10th Anniversary Issue

BYTE

THE SMALL SYSTEMS JOURNAL

SEPTEMBER 1985 VOL. 10, NO. 9

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HOMEBREWING

CIARCIA'S SUPER SYSTEM

6-MHz, HD64180 Z80-compatible, 256K RAM, 2 serial, 1 parallel, floppy controller, ZCPR3 with RAM-disk software

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you're in

Candidate Search Update

FILE: *Resumes*
SEARCH DATE: *5/20/85*
CLIENT: *Splendora Gourmet Baby Foods*

FIND

EXPERIENCE = *Marketing Manager*
FIELD = *Foods/Infant*
SIZE = *500+ Employees*
SALARY REQ. = *$40-$50,000 Per Annum*
LOCATION REQ. = *Detroit*
-or-
RELOCATABLE = *Yes*

Name	Experience	Salary	Education	Age
Antosz, Hank	1978—Present Pinz-Pinz Baby Food 1976—1978 Heath Baby Products	$45,000	Harvard MBA/Mktg.	33
Brown, Bob	1984—Present Liz for Kids 1982—1984 Bonnie Babe, Inc.	$48,000	CSUN/Marketing BA	26
Hayden, Steve	1979—Present Heath Baby Products 1975—1979 Nummy Tummies	$43,000	UCLA/Sociology BA Harvard MBA	35
Morrison, John	1977—Present Camille Grocers, Ltd. 1974—1977 Georgie Porgie of London	$40,000	Oxford/Marketing	32
West, Nick	1961—Present Bonnie Babe, Inc.	$47,000	UCLA MBA/Mktg.	42



100 Aldous Avenue
Suite 7-J
Detroit, Michigan

May 20, 1985

Mr. Greg Helm
Vice President, Marketing
Splendora Gourmet Baby Foods
2200 Michigan Place East
Winnetka, Illinois

Dear Mr. Helm:

As a busy executive you know that accomplishing your many professional objectives is a full-time job.

And the last thing you need is to take time out of your hectic schedule to search for a new team player. That's where Recruit-A-Suit can help!

We're a full-service recruitment firm with our finger on *more than 5,000,* meticulously selected, aggressive, ambitious, highly-qualified professionals not unlike yourself.

SUCCESSFUL PLACEMENTS
100
75
50
25
1981 1982 1983 1984

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One more reason we enjoy the highest success rate in the industry! Though our fees remain among the most competitive in the industry.

Enclosed, please find more information on our client references, case histories and terms of business for your reading pleasure.

And next time you find yourself faced with an empty swivel chair, don't hesitate to call Recruit-A-Suit.

Sincerely,

Cynthia Shern

Cynthia Shern
Senior Associate

CS:dh

enc.

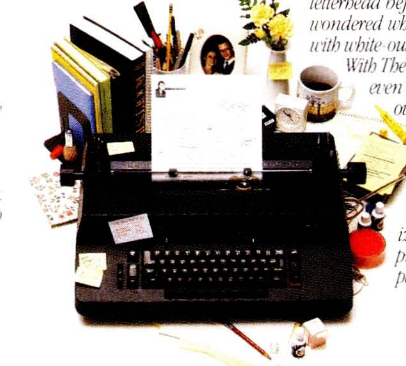
Personality
5 4 3 2 1 0

Leadership
5 4 3 2 1 0

Experience
5 4 3 2 1 0

Communicatio
5 4 3 2 1 0

Using database management programs you can store, retrieve and sort information in an almost unlimited number of combinations. As opposed to the way you're probably doing it now. Above, we've located eligible candidates by salary and work experience. But database management is also handy for things like generating master mailing lists. Creating invoices. Sorting by zip code. Checking inventory. No files to lose. No cross-referencing your Rolodex. No paperclips.*



In business, people often meet your letterhead before they meet you. Ever wondered what a typewritten page stiff with white-out says about your business? With The Macintosh Office you can even design and print your own letterhead, plus combine publication quality text and graphics for a lasting first impression. More important, you can send personalized letters to as many prospects as you have paper.



usiness you're in, business.

Candidate Profile Analysis

Candidate 1
Candidate 2
Candidate 3
Candidate 4
Candidate 5

Each graph represents seven to ten pages of test information per candidate.

Individual tests are available for your review at your request.

As these comparative charts indicate, all candidates tested competitively in the four areas.

However, based on further in-depth study, including extensive personal interviews, we highly recommend you interview candidates 4 and 5 as soon as possible.

Our office will be contacting you immediately to set up these interviews at your earliest convenience.

Recruit-A-Suit Income Statement
Fiscal Year Ending 9/30/84

	Q1	Q2	Q3	Q4	Year-end
SALES					
Ann Arbor					
Fees	20,000	19,000	22,000	17,000	78,000
Commissions	52,000	45,000	48,000	42,000	187,000
Total Ann Arbor	72,000	64,000	70,000	59,000	265,000
Detroit					
Fees	44,000	46,000	42,000	39,000	171,000
Commissions	68,000	72,000	64,000	62,000	266,000
Total Detroit	112,000	118,000	106,000	101,000	437,000
TOTAL SALES	184,000	182,000	176,000	160,000	702,000
OPERATING EXPENSES					
Ann Arbor					
Payroll	30,000	30,000	33,000	30,000	123,000
Taxes	2,500	2,500	2,600	2,500	10,100
Auto	1,200	1,200	1,200	1,200	4,800
Telephone	600	600	600	600	2,400
Rent	8,000	8,000	8,000	8,000	32,000
Utilities	500	500	500	500	2,000
Dues/Subscrip.	100	100	200	100	500
Advertising	3,000	3,000	4,000	4,000	14,000
Travel	1,000	1,000	1,000	1,000	4,000
Entertainment	1,500	1,500	1,750	1,500	6,250
Office Supplies	300	300	300	300	1,200
Ann Arbor Total	48,700	48,700	53,150	49,700	200,250
Detroit					
Payroll	50,000	52,000	50,000	50,000	202,000
Taxes	4,200	4,400	4,200	4,200	17,000
Auto	2,400	2,400	2,400	2,400	9,600
Telephone	1,200	1,500	1,500	1,200	5,400
Rent	9,100	9,100	9,100	9,400	36,700
Utilities	800	800	800	800	3,200
Dues/Subscrip.	200	250	200	200	850
Advertising	3,000	3,500	3,500	3,000	13,000
Travel	1,200	1,500	1,200	1,400	5,300
Entertainment	1,600	1,800	1,600	1,400	6,400
Office Supplies	400	400	400	400	1600
Detroit Total	74,100	77,650	74,900	74,400	301,050
EXPENSES TOTAL	122,800	126,350	128,050	124,100	501,300
NET PRE-TAX PROFIT	61,200	55,650	47,950	35,900	200,700

If a picture is worth a thousand words, business graphics like these could cut meetings and presentations in half. We've taken information on five candidates stored in one software program, copied it into another program, where it was used to create these comparative bar graphs. Once your data is entered, this particular software program gives you your choice of 42 different graph configurations. You can preview your material (whether it's candidates, costs or cookies) in each configuration to decide which chart or graph most persuasively makes your point.

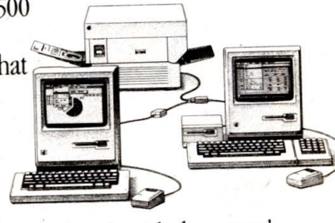
*As you well know, business involves innumerable number-related tasks, not the least of which is generating income and expense statements like this one. Should you want to change any of the entered items—to take a look at the effects of opening a new office or decreasing your staff—a spreadsheet program like Multiplan** will automatically recalculate the entire document. (Here, we've copied it into MacDraw™ and enhanced it for presentation purposes.) It not only saves hours of entering, double-checking and erasing, but when teamed up with our LaserWriter printer, it produces a printout impressive enough to show a bank president. Fast enough for this afternoon's meeting.*

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Epson, ABC, and Indesys on FM Radio

NANOBYTES

William C. Lowe, president of **IBM Entry Systems Division**, was quoted in a recent *New York Times* interview as saying that the IBM PC II "is a mythical product," which seems to end any discussion of that matter. Another IBM spokesperson fingered a defective chip "in less than 10 percent" of IBM's PC ATs as the culprit responsible for its notorious crashes. . . . **International Measures and Communications (Meacomm)** of Houston, TX, is offering a 6502 and Applesoft BASIC emulator for Apple's Macintosh computer, allowing many Apple II programs to run on the Mac. Mac+|| has communications software for the Apple II and Macintosh so programs can be exchanged using the Imagewriter cable. . . . **Personics** of Concord, MA, offers a head-rotation-detection system that replaces the mouse on Apple's Macintosh. The View Control System includes a small unit that generates high-frequency sound, a headband with three small sound detectors, and a two-button keyboard add-on to activate the headband and simulate the mouse button. The $200 Macintosh version is available now; an IBM PC version is also planned. . . . **Graphic Software Systems** has developed software allowing microcomputers to act as intelligent graphics workstations when attached to a host computer that also uses the software. GSS-Grafstation employs the Virtual Device Interface (VDI) developed by GSS. The company will license the software to OEMs for $250 per copy. . . . **Future Computers**, Croydon, U.K., is offering to OEMs a low-cost computer compatible with IBM's PC AT. Called the FX 100, the machine features a 10-MHz 80286, two 1.2-megabyte floppy-disk drives, 512K bytes of memory, a proprietary display-adapter card compatible with the Hercules monochrome graphics card, and a mouse. End-user price is reportedly $2995. . . . Korean electronics giant **Samsung** has added its name to the long list of makers of IBM PC AT-compatible computers. With a color monitor and a 20-megabyte hard disk, the Samsung OX-85 reportedly will cost $4895. . . . **Micrografx Inc.**, Richardson, TX, announced In*a*Vision, a drawing program that runs either alone or under Microsoft Windows using pull-down menus and multiple-window viewing. The $495 program is targeted at drafting and CAD applications. . . . **McTel** of Bala Cynwyd, PA, has a $50 program, Electronic Envelope, that encodes binary files for transmission through electronic mail systems that permit only ASCII text to be exchanged. . . . **Hitachi** displayed a portable computer with a detachable keyboard and a liquid-crystal display. The company predicted that OEMs could sell the system with 256K bytes of RAM and one 3½-inch floppy-disk drive for less than $2000. . . . **NEC Electronics** said its two-chip set allows design of a hard-disk controller using only 10 chips. The μPD7261 and μPD9306 pair will sell for $25 in OEM quantities. . . . **Qume**, San Jose, CA, has obtained exclusive rights to market a **Hitachi** 10-page-per-minute laser printer in the U.S. beginning in early 1986. No additional details about the printer were available at press time. . . . **Addison-Wesley** said its Macintosh version of True BASIC would be available late this year. . . . **Digital Research** formally introduced the GEM DOS operating system for the 68000 series of microprocessors. The debut followed an agreement with **Northern Telecomm**, whose 68010-based Meridien computer system will now support GEM and GEM DOS. . . . **National Semiconductor's** proprietary two-board computer includes its 32016 processor along with floating-point and memory-management chips. With 1 megabyte of RAM, the board set is $2800. . . . **Charles River Data Systems** has developed a UNIX System V computer system that uses Motorola's 68020 processor. Initial buyers will get a 140-megabyte hard disk, 4 megabytes of RAM, UNIX System V, 12 serial ports, and other software for $24,900. . . . **Sord Computer** also has a six-user UNIX System V computer. Sord's 68010-based Unibox includes a 20-megabyte hard-disk drive, one 1.2-megabyte floppy-disk drive, 1-megabyte RAM, and ports for two users for $4695. A 68020-based

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L·E·T·T·E·R·S

Evidence of Support

During the past few months I have read several letters from your readers complaining about the poor support that they have received from the manufacturers of their personal computers. Recently I needed additional information about the I/O ports on my AT&T PC 6300. I tried in vain to find a computer store that sold the *System Programmers Guide* or a person who could answer my questions. In desperation, I sent a letter to AT&T describing my problem and asking for additional information. To my surprise, I received a letter from AT&T less than 10 days later. The letter explained that the *System Programmers Guide* had just been released, so some computer stores would not yet have it, and gave instructions on how to order the manual directly. The letter also answered my technical questions completely and even included photocopies of the pertinent pages from the *System Programmers Guide*. I ordered a copy of the manual over the telephone and received it less than a week later. Well done, AT&T! Keep up the good work! I am very happy with my AT&T 6300 and the support from AT&T.

Dr. Michael J. Pelletier
Cincinnati, OH

Many times I have read about how a particular software firm provided less than adequate service. However, I would like to be one individual from the silent majority who speaks out for a company that went above and beyond the call of duty.

I read an evaluation of a product from Morgan Computing called Trace86. The article described a save-screen function that Morgan Computing (MC) did not implement. I wrote to MC, and the people there said it was their fault and that they would provide an update with that feature when they had it working properly. I waited several months, and I had almost given up when I received the update and documentation free of charge (the call of duty).

Later, I read about Advanced Trace86 (AT86). I called MC. The cost of the update was $99. The people at MC must have remembered me, since they provided me with AT86, a letter stating they appreciated my business despite the long wait for an update last time, and a complimentary copy of Disk Toolkit, a $75 value (above and beyond the call of duty).

I feel that Morgan Computing deserves to be recognized as one company that puts customer satisfaction high on its list of priorities.

Stephen Moffett
Bryan, TX

Both Sides of DEC's Rainbow

I must take issue with Jared Sherman's letter in the June issue (page 32) attacking the DEC Rainbow 100. I own a Rainbow 100B with 256K, CP/M, and MS-DOS. I also assembled, tested, and use several of these in my job at the University of Louisville. I must take exception to Sherman's criticisms and to Rainbow critics in general.

His first assertion was that CP/M-86/80's BACKUP utility "eats" files. I have backed up hard disks on several occasions with absolutely no problem. I have a feeling that Mr. Sherman has not correctly specified all of the parameters in his backup setup commands. Digital does not know of any errata in its documentation regarding the hard-disk backup.

MAINT does have a known bug regarding hard disks. Digital should have told Sherman that MAINT was not designed to be used with a full hard disk (by full I mean 100+ files) to begin with.

I find it hard to believe that DEC's customer-service line was purposefully evasive in answering his questions. I have called the line on three separate occasions, and I found the people in Atlanta to be both courteous and knowledgeable, even when one of my problems involved a non-Digital modem.

I am writing this letter with WordStar 3.3. We use WordStar extensively here, and I have heard no complaints about it not editing a file over 30K. Again, I believe the user and not the system to be at fault.

MS-DOS manuals are a problem. It is too bad that to get the programming documentation, one must shell out $75 for the MS-DOS programming manual (not $250; the manuals have been repackaged and are now sold separately from DEC direct). However, the hierarchical directory structure is documented in the *Advanced User's Guide* provided with MS-DOS in chapter 3, which is entitled "More About Files."

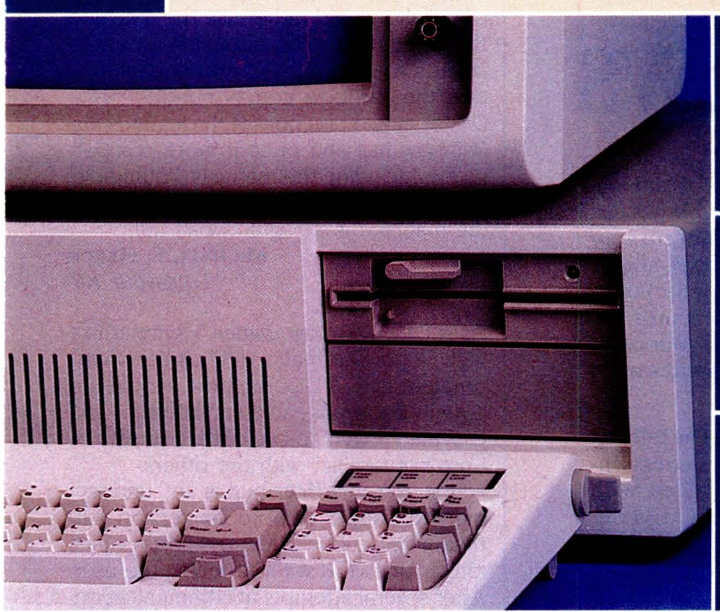
I recently purchased the $75 *Hardware Documentation* set and find both manuals complete and well written. Why DEC didn't include this with the machine is unclear to me. DEC would probably develop a real following among programmers if it would include these with the machine. The Rainbow is a well-designed and well-documented machine, and Digital should take advantage of this more than it does.

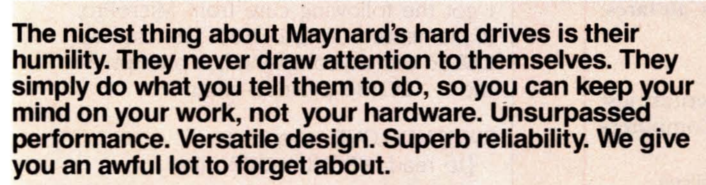
I was most interested in Mr. Sherman's story about his hard-disk upgrade. I personally installed 25 hard-disk upgrades for U of L some months back with no problem. The only thing I can figure is that he had a 100A with a motherboard problem. Nowhere in the documentation that I have can I find the fact that you need a new CPU motherboard to install that upgrade. According to the documents we received, to upgrade a 100A requires a new power supply (included with the 100A hard-disk upgrade), the controller board (included), and the drive cable.

Like any complex piece of electronic equipment, proper maintenance is essential. Mr. Sherman probably does not have his system under any kind of maintenance agreement with Digital. When I purchased my Rainbow, a year of on-site maintenance was included. I believe the company has discontinued that offer, but I plan to put my system on depot (carry-in) maintenance when my warranty expires. Mr. Sherman should consider doing the same. One bad system board will pay for the agreement for about a year and a half.

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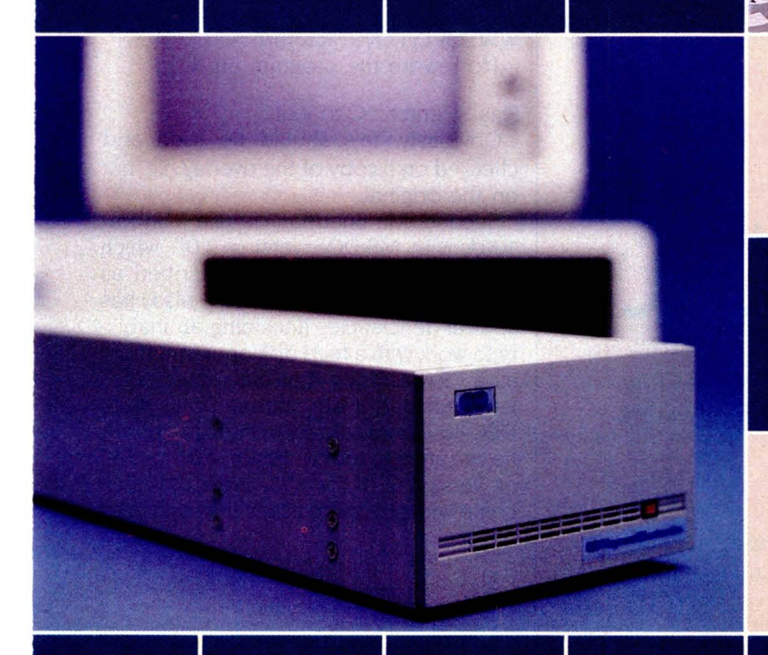
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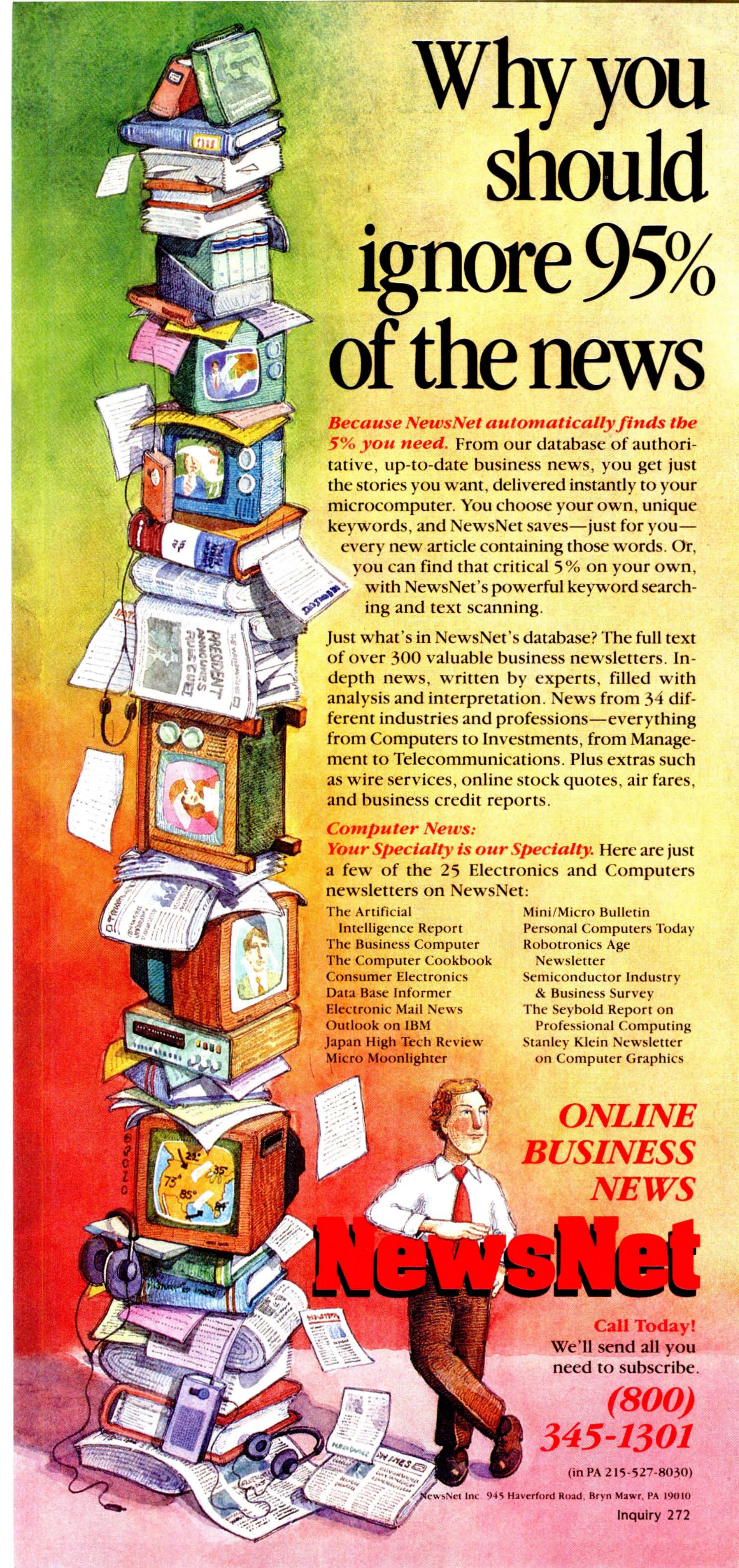


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Inquiry 235



It is unfortunate that horror stories like this continue to plague the Rainbow. I have owned my machine for about a year now and have had no problem with it. The Rainbow is an excellent product for those of us who would rather use the machine than spend our time buying upgrade boards to give our PC the functionality that the Rainbow comes bundled with. Digital should take note of the features the Rainbow has and price it more competitively. Including the manuals would help also, because no one can know how good the machine is if Digital won't tell.

MICHAEL E. HARPE
Louisville, KY

As a DEC Rainbow owner, I sympathize with Jared Sherman's difficulties. Unfortunately, not all DEC support people are equally knowledgeable and helpful. I can provide answers to two of his complaints. I am not familiar with the others.

First, the WordStar bug is an "undocumented feature" of WordStar version 3.30 that promiscuously destroys parts of files longer than 32K without telling the user. After several attempts at communication, I got the following cure from MicroPro, implemented using DDT86: First call up DDT86 with no command-line prompt. At the "-" DDT86 prompt, enter

RWSOVLY1.OVR <return>
{to read WSOVLY1.OVR into memory}
S4A52 <return>
{to set bit at 4A52 hex}

The program will respond with "B1:" Enter "B2," a carriage return, and a "." to tell the program you are finished changing bytes. Then enter

WWSOVLY1.OVR <return>
{to rewrite the program on disk}

Finally, enter ^C to exit.

Obviously, this should be tried and checked on a copy of the overlay file, not on the original.

Second, Mr. Sherman owns a Rainbow 100A with MS-DOS version 2.01, which has a user's manual best described as abysmal. The software itself also has several deficiencies (including an inability to work with a hard disk or use memory as a "RAM disk") that are remedied in later versions. If Mr. Sherman calls (800) DEC-8000 and asks for contract support, he can arrange to buy version 2.05 for $65 or version 2.11 for $95, both of which come with adequate user's manuals. And

(continued)

LETTERS

yes, I would agree that DEC is charging too much for these upgrades. If Mr. Sherman is happy with version 2.01, a cheaper solution would be to buy a book on MS-DOS from an independent publisher. Files with technical information on Rainbow firmware interrupts are available on the VAX Forum (PCS 16) of CompuServe.

Mr. Sherman is correct that DEC made the inexcusable decision to solder in the ROM, at least on the 100A. This ROM requires the system to be booted from a floppy disk at start-up but otherwise allows installation and use of a hard disk.

That said, I should add that I am happy with my DEC Rainbow. It is basically a very good machine. Its shortcomings seem to result from Digital's being oriented to the mainframe market. Its design approach as well as upgrade and service policies are geared toward corporate customers owning large machines. When you tell Digital people that you're an individual owning one personal computer, they know not what to think.

CARL D. NEIBURGER
Los Osos, CA

The June Letters column contained yet another blast at the DEC Rainbow. A Mr. Sherman decried "bugs" he had found, some so terrible one cannot imagine how anyone could use such a machine. I have been developing software on just such a machine day in, day out for more than two years, and I have never experienced any of the bugs Mr. Sherman mentioned. The only bug I've ever found is a very minor one in the Rainbow Editor (RED), where a randomly huge number of pages often display when one requests to page backward. The Rainbow works quickly, dependably, and effortlessly. I truly enjoy using it.

I do, however, share Mr. Sherman's disdain for DEC's documents. They are often sinfully incomplete. But all in all, I find them easier to garner information from than most.

PAUL HENDERSON
Waynesboro, VA

ENOUGH ON THE IBM PC!

I greatly enjoyed the multiprocessor articles (May). Keep up the excellent coverage of new technologies in hardware and software.

Let me register a vote against IBM PC coverage. It's available in overabundance from almost every other magazine. The IBM PC was out-of-date technology the day it was released, and that was a long

(continued)

 Inquiry 175 for End-Users. Inquiry 176 for DEALERS ONLY.

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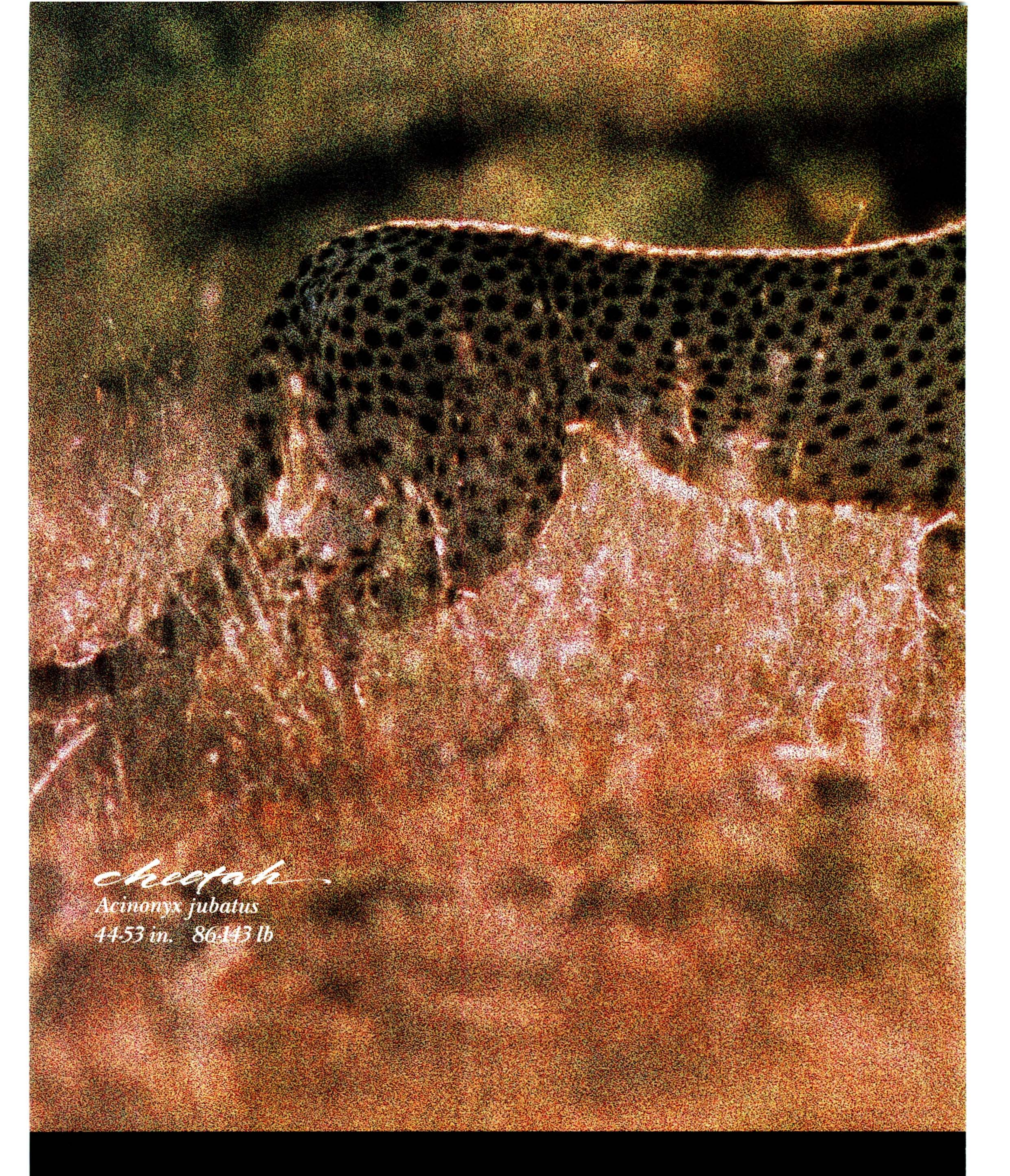
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Inquiry 3 for End-Users.
Inquiry 4 for DEALERS ONLY.





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TAPE: PC/T
Inquiry 361 for End-Users. Inquiry 362 for DEALERS ONLY.

time ago. I predict that the IBM PC AT will be in the same position very soon.

ALAN ROBINSON
Jamaica Plain, MA

THE HISTORY OF Ø

G. Michael Vose's conjecture (Book Reviews, February, page 65) that Alan Turing originated the practice of writing zero as Ø to differentiate it from the letter O is wrong, and William D. A. Geary (Letters, June, page 18) has correctly identified it as being common in telegraphy long before Turing. Military radiograms in World War II were always so typed. But there is more to the slashing story.

Telegraphic messages were chiefly alphabetic letters so the rarer symbol, the numeral, was slashed. In early computing the opposite was the case; the numerals were common while the letters were rare, so for years it was considered good computing practice to slash the handwritten letter O. As late as the 1970s programming textbooks gave this advice and further suggested putting a horizontal bar through Z to distinguish it from 2 and putting a horizontal cap and foot on I to distinguish it from 1.

Now that the majority of the symbols used in computing are letters, we have gone back to slashing the zeros, and since input is increasingly entirely prepared on a keyboard and not handwritten we are less concerned with the Z/2 and I/1 confusions.

ERIC A. WEISS
Springfield, PA

MORE ON STRUCTURED PROGRAMMING

Nearly 20 years after the structured programming revolution began and roughly a decade since Pascal and C became important languages and at a time when almost everyone recognizes the value of structured programming, it is sad to see a letter such as the one titled "Toward a Less Structured Approach" (May, page 458) by Erwin S. Strauss. I'm sure that it is important that people who are new to the field see the opposite point of view.

There is hardly one sentence in the entire letter that can pass unchallenged! Mr. Strauss presents two programs side by side and claims that one is structured while the other is not. In fact, both are examples of structured "code"—i.e., both use a counted loop, and one uses an IF. . . THEN. . . ELSE. The flow is from top to bottom, and neither uses a GOTO. I call both of these examples "code" rather than

(continued)

programs because both are terrible examples of programs, structured or otherwise.

The attack by Mr. Strauss was prompted by the poorly designed index in the Modula-2 book. Sequential entries in the index are printed horizontally adjacent to each other rather than vertically. As poor as it is, it is at least an index for the book. The first code segment presented by Mr. Strauss works only for even values of N—a restriction stated by him but given in the same breath that he attacks the other code that works for all values of N. I dislike this indexing scheme as much as anyone, and I haven't the foggiest idea why it was done this way. I am certain, however, that the strange form of the index has about as much to do with structured programming as does the color of the cover.

The second code segment, which Mr. Strauss claims contains a higher level of "sensitivity to the user," is so bug-infested that it is insulting to the user! If N (the number of elements in the index) is less than or equal to PL (the number of lines on the page), it omits printing every other index element. If N is one greater than PL but still less than $2*PL$, the program produces a correct listing for indexes 1, 2, . . . , $N-PL$, $PL+1$, $PL+2$, . . . , N but again omits all the even indexes between $N-PL$ and PL. Finally, if N is greater than or equal to $2*PL$, it will print out a correct index for the first few pages but will always foul up the last page. It turns out that this collection of code will produce the correct answer only when N is an even multiple of PL. So much for sensitivity!

The letter continues stating that the first is a structured program because it "has fewer lines, fewer statements, fewer variables, it's easier to read and understand at a glance, etc." (One could only imagine what "etc." includes.) I don't know of any texts that claim any of these are characteristics of structured programming. Certainly structured programs are easier to understand, although not necessarily at a glance. Often structured programs are longer and use more variables than unstructured code! (See listing 1 for an example.)

Clearly, structured programming has nothing to do with sensitivity (or its lack) to the user. Years ago it was demonstrated that any "correct" program could be written in a structured fashion. Only programmers are responsible for the program's sensitivity to the user. The letter continues by attacking structured programmers because they insist on producing bug-free code! Bug-free code? I consider myself a "structured programmer" and I program that way because it produces clean code early on in the code-development cycle; it gives me more time for other programming projects because I don't spend much time chasing down foolish bugs. The cost of structured programming that Mr. Strauss speaks of is not one of sensitivity but one of sitting down with a problem and solving it long before you begin to type characters at a computer. I enjoy programming so much that the satisfaction of working on many projects and producing well-written programs is worth the so-called cost of thinking out ahead of time. Strauss's two code segments are prime examples of what happens if you are not willing to pay that price.

The rest of the letter's attack on struc-

(continued)

Listing 1: *David R. Stampf's example of a structured program.*

```
PL := 60;                              { Lines/page }
                                       { N is the number of entries }
FULL_PAGES := N DIV (2*PL);            { Full pages - Hmmm, maybe k columns? }
START := 1;                            { Start with the first entry }
FOR PAGE := 1 TO FULL_PAGES            { Full pages first - even if none }
      DO BEGIN
         FOR ENTRY := START TO START + PL - 1
               DO WRITELN(INDEX[ENTRY],'              ',INDEX[ENTRY + PL]);
         START := START + 2*PL;
         END;
{ Any partial pages? }
LINES := N - START + 1;                { Find lines left to print }
IF (LINES > PL)                        { Watch out for > half pages }
   THEN LINES := PL;
FOR ENTRY := START TO START + LINES - 1
      DO IF (ENTRY + PL) <= N
            THEN WRITELN(INDEX[ENTRY],'      ',INDEX[ENTRY + PL])
            ELSE WRITELN(INDEX[ENTRY]);
{ The above works for all values of N - even/odd/big/small/+/- }
```

tured programmers, gurus, and the like is simply redundant—Strauss has an equally naive opinion of good programmers as he does of structured programming.

Finally, the last paragraph seems to be hedging a bit—structured programming is okay if . . . . Evidently, he hasn't the foggiest notion of what the goals of structured programming are. I will never program my zillionth database application. If I ever do it, I hope to do it once, then reuse the same code. If I do it right the first time, I can use the same technique over and over, freeing up time for me to explore new systems. Too bad Mr. Strauss will be trying to debug his index program, for if you start by writing buggy programs, debugging always comes later.

David R. Stampf
Shoreham, CT

Erwin Strauss seems to be confusing two important ideas, that of the structure of a program on the one hand and that of its "usefulness for any specific purpose" (which most vendors go to a lot of trou-

(continued)

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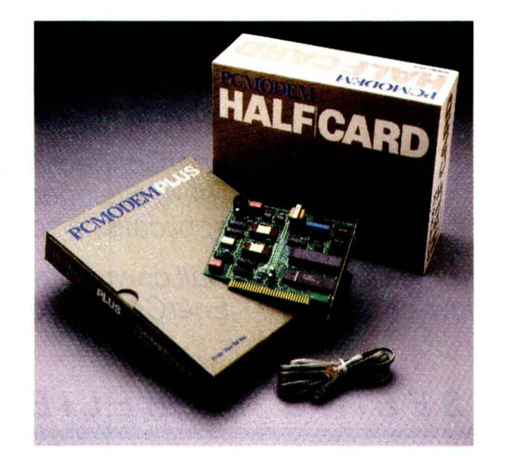
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ble to advertise but then disclaim in their license agreements) on the other. I wholeheartedly agree with Mr. Strauss's view that a program should not be simplified to the point that it does no useful work.

In his example of two programs to print an index in two columns, he is in error when he describes the first as structured and the second as unstructured. In fact, his second program clearly shows the same structure as the first, extended to add the concept of a page and to rearrange the data. I could give an unstructured version of the second program, but yours is a family publication. Suffice it to say that it would use GOTOs in the manner Dijkstra considered harmful. The two programs illustrate the concept of stepwise expansion of a simple algorithm to solve a more complicated problem. Structured methods were developed in response to the problems of developing large, complex programs. Of course, if two programs solve the same problem, the simpler one is to be preferred. If Mr. Strauss's gurus tell him his two programs do the same thing, or that he should choose the first anyway, then they are false prophets and he should cast them out.

A programmer can be competent but fail to understand the methods he uses. Structure in a programming language is like good grammar in a natural one. It lends clarity of expression. Spoken language may exhibit looser grammar than formal written language, but a speaker who has mastered grammar is more likely to be correctly understood by his listeners. Not all programs should be written in the formal style appropriate to a legal contract, but a programmer with a good grasp of structure can use it even in his less formal utterances. If he does so, it is more likely that his program will tell his computer what he really wants it to do.

Our choice of a language may be like using the jargon appropriate to a profession. It can provide a useful shorthand for communication with other initiates, but it can be limiting if used to express thoughts in a wider realm. Jargon frequently reads as very poor English. Some computer languages are also poorly suited to general applications, even though they may be quite satisfactory for chosen purposes.

If a language enforces a structure, an experienced user will think within that structure. That is why it is important to teach structured languages like Pascal or Logo early if possible. You can then learn other languages as appropriate. For example, Pascal is not suitable for systems program-

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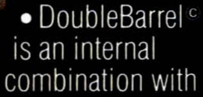
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ming (not because of the structures provided for flow of control but because it imposes restrictions on access to memory and I/O in order to guarantee correct matching of data types in common application programming situations and doesn't provide for multitasking). When using an unfamiliar language, a programmer may well display the accents of languages he knows better. Perhaps a Pascal accent could add real charm to a BASIC or assembly-language program.

JOHN MAINWARING
Raleigh, NC

MAKING BASIC MORE POWERFUL

I programmed a bit of FORTRAN in college in the early 1960s and then got into programming in a bigger way in about 1967 with BASIC. It's the language I cut my programming teeth on.

BASIC didn't have a very good reputation in those days. I taught after-hours classes in a largely FORTRAN-oriented company, and some of my students would come to class shaking at their very foundations because their "sophisticated" FORTRAN colleagues in the terminal room would chide them about their choice of language, even corrupting the BASIC acronym to mean Baby's All-purpose, Simple Instruction Code.

But we had an extraordinarily good version of BASIC at our disposal, and I was a master of it. I'd accumulated many imaginative and provocative tricks up my sleeves to use things like strings, logical variables, complex numbers, and matrix functions to solve complex problems in elegant, unexpected, and simple ways. Had any one of those 1960s computer yuppies challenged me to a FORTRAN-versus-BASIC shoot-out and let me pick any one of two dozen problems to solve, I'd have beat the diapers off them.

Since then, I've gone on to program a fair amount in APL, FORTRAN, Pascal, Ada, some C, and bits and pieces of other languages on UNIX and other operating systems. And what I've found is that each language has its application.

I don't do much hands-on programming any more. But I make a hobby of devising yet other new tricks for BASIC; these days, I get a kick out of programming it to mimic the good software and engineering features of other languages. And that's what drew my attention to Arthur Huston's article "Structuring BASIC" (June, page 243).

Mr. Huston did a good service for the BASIC world with his article on building libraries, but we can go farther than he went when we start talking about mimicking the type-checking, procedure, error-processing, GOTO-less programming, and other features inherent in other languages. For (believe it or not) it is possible to emulate these things in a good BASIC and make your programs incredibly readable and debuggable along the way. Why, I've even emulated, in a crude, first-cut way, Ada's *generic* package—not to mention TBD's workers-and-managers architecture and the principles of top-down programming and interface development.

It's fun, intellectually stimulating, and doable—if you set your mind to it and don't victimize yourself with that sense of Baby BASIC.

GENE BARNETT
Redondo Beach, CA

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BYTE'S BUGS

Conversion Algorithm Bug

Mark Werley, a BYTE reader from Yuma, Arizona, reported a bug in David L. Kahn's article "A Unit-Conversion Algorithm." (See page 151 of the March BYTE.)

Line 310 in listing 1 (page 154) should read as follows:

```
310 IF MID$(I$,X,1) = " " OR X> = LEN(I$)
   THEN 320 ELSE X=X+1:GOTO 310
```

Mr. Werley also modified the program so that it will run on his Commodore computer, which has neither an ELSE nor an ELSE IF command. He recommends inserting

```
310 IF MID$(I$,X,1) = " " OR X> = LEN(I$)
   THEN 320
315 X=X+1:GOTO 310
```

Mr. Kahn tells us that other readers have pointed out one more error. In line 7250 (page 156), the DATA has an incorrect value statement. As it appears now, the program will produce inaccurate answers in any conversion involving the term ACRE. The correct value is 2.4710536E-4.

Our thanks to Jack Heddon and Ray Isenson for taking the time out to report this bug.

The PRINT CHR$(12) in lines 10, 130, and 4000 requires some clarification, according to Mr. Kahn. In most versions of BASIC a CLS statement would have been preferable to the PRINT CHR$(12), but Mr. Kahn's BASIC compiler does not support the CLS statement. With both his compiler and his interpreter, the PRINT CHR$(12) worked just fine.

Also note that line 130 is unnecessary in the MS-DOS version of the program. In addition, the TRS-80 version prints some material between lines 10 and 130 that is not needed with MS-DOS. The line was left in to minimize the differences between the two versions.

"In Brief" Error

In the "In Brief" column that accompanied Laine Stump's article "The Kit Solution," we supplied some erroneous information. (See page 196 of the March BYTE.)

The Slicer comes with a CP/M-86 BIOS. The operating system itself is $85. Concurrent CP/M, as of press time, is unavailable and unpriced.

AI Book Available

A number of readers have reported that Focal Press of Stoneham, Massachusetts, no longer carries Mike James's *Artificial Intelligence in BASIC*, which was recently reviewed by Norman J. Chaplin. (See April, page 68.)

This book can be ordered from Newnes Books, 84-88 The Centre, Feltham, Middlesex TW13 4BH, England.

Our thanks to Norman J. Chaplin for tracking down a distributor for this book.

FEEDBACK

Alternative Approaches to Structured BASIC Programming

Jack M. Fischer, network manager for the Tulsa Computer Consortium, recently wrote us lauding Arthur Huston for the "excellent case [he makes] for writing structured BASIC programs." (See "Structuring BASIC," June, page 243.)

Mr. Fischer notes that Mr. Huston's approach to structured BASIC programming relies heavily upon adherence to rules for line numbering and for the naming of variables and subroutines.

Programmers at the Consortium, reports Mr. Fischer, have developed a number of tools and techniques that eliminate the need for strict rules. One such technique, FLOAT, lets you float BASIC subroutines between programs and libraries by providing you with an insert capability to eliminate the need for line numbering. Another tool compensates for the lack of local and global variables.

If you want to learn about the Consortium's approach to structured BASIC programming, write to the Tulsa Computer Consortium—Structured BASIC, POB 707, Owasso, OK 74055. Please enclose return postage.

UPDATES

Systems Transfer Documents Between Word Processors

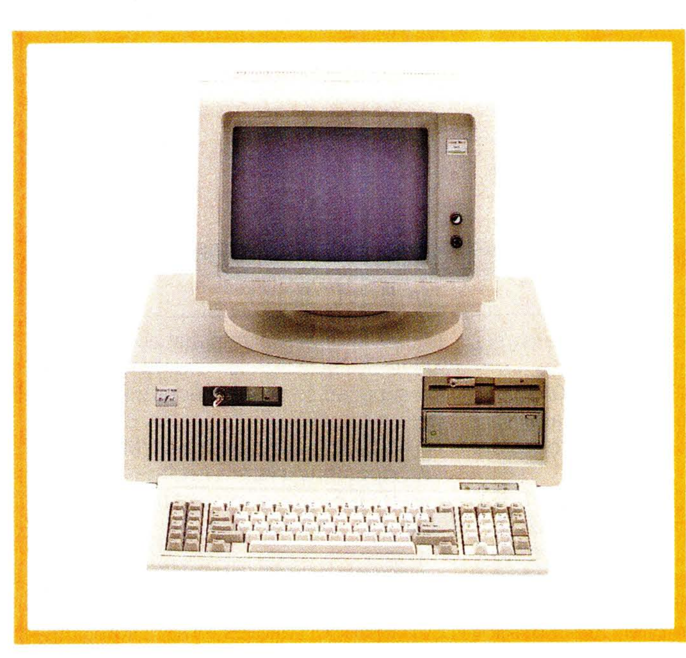
Flagstaff Disk Conversion Equipment distributes systems that transfer document files between most word-processing equipment and the IBM PC, PC XT, and PC AT. Word processors supported include CP/M systems, Displaywriter, OS/6, Wang, Xerox, and IBM S/32, S/34, and S/38.

The Diskette Connection lets you read and write most 8-, 5¼-, and 3½-inch disks. It comes with a PC controller card, an 8-inch floppy-disk drive, and a cable.

The Word Connection, used in conjunction with the Diskette Connection, lets you transfer disk-based document files between word processors. Word Connection programs use IBM-standard Document Content Architecture (DCA-RFT) to transfer document files and such parameters as page size, tabs, headers, margins, and typesetting control characters. The conversion is said to take place at 40 pages per minute. Transferred documents can be sent directly to a mainframe via IBM's PROFS and DISOSS electronic mail.

Flagstaff Disk Conversion Equipment is a distributor for Flagstaff Engineering Inc., which produces the Diskette Connection and the Word Connection. The Diskette Connection is $1099, and the Word Connection is $695. Contact Flagstaff Disk Conversion Equipment at 1805 North Beaver, Flagstaff, AZ 86001, (800) 821-7493, ext. 236; in Arizona, (602) 774-5422. ■

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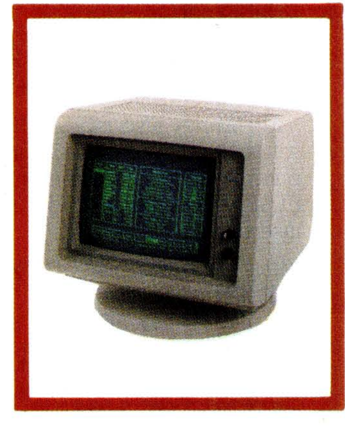
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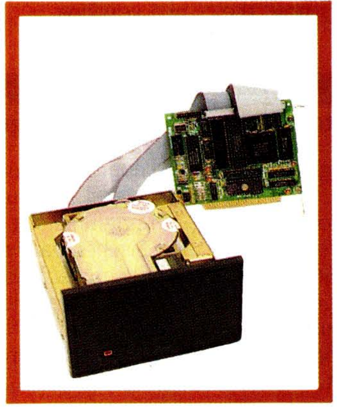
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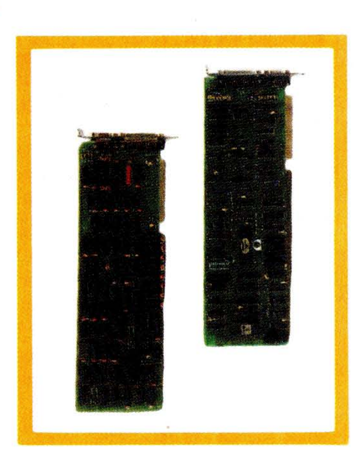
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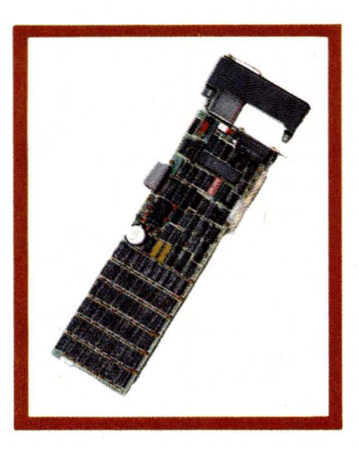


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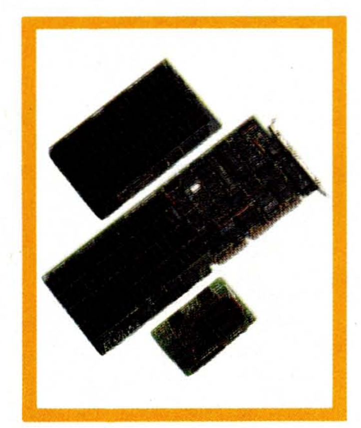


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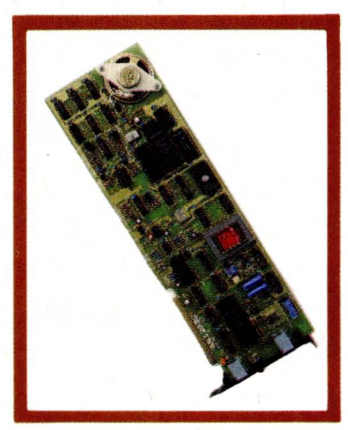
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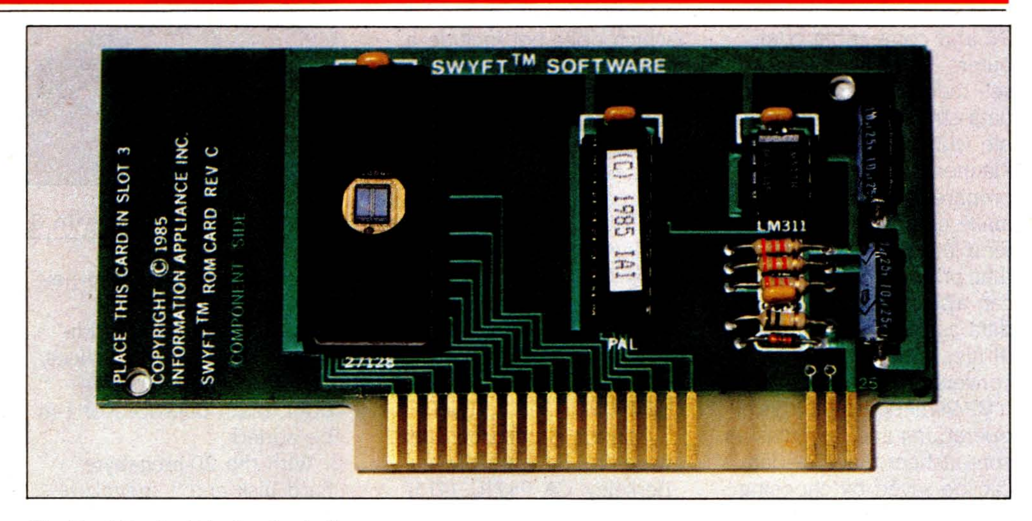
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FIRST LOOK

Application Environment for Apple IIe



The SwyftCard add-in for Apple IIe computers.

The SwyftCard from Information Appliance Inc. is a text-oriented data-handling product based in ROM that comes as an add-in card for the Apple IIe. The brainchild of Jef Raskin, former head of the Apple Macintosh development team, the card offers word-processing, information-retrieval, program-development, calculation, and telecommunications capabilities in an integrated package.

The SwyftCard environment is designed for speed. Because the program resides in firmware, there is no need to access a disk for program information. All data manipulation occurs in memory, roughly 40K bytes on a 64K-byte Apple IIe. The SwyftCard uses a disk format that equates one disk to that 40K-byte figure; this wastes some disk capacity, but the only times the program really has to use the disk drive are at the beginning of a work session (retrieving data) and at the end (saving it).

The program is available directly from the card's firmware when you turn on the computer. Since the SwyftCard serves as its own operating system, you need a single disk only to store data. Thus you can use the card with a minimal hardware setup: an 80-column 64K-byte Apple IIe, a monochrome monitor, and one disk drive. The SwyftCard does not interfere with other Apple software; if you place a program disk in the drive, one keystroke removes the SwyftCard system and loads the new program.

The environment is essentially a continuous scroll of text divided only by page breaks. You enter data as with any word processor, and the SwyftCard provides all standard word-processing functions. There are no files as such; if you wish to print a section of the scroll, you mark the top and bottom of the region and send the block to the printer. Formatting for printing is automatic, although you can change parameters when you want. Rapid movement through the text scroll is provided by a search algorithm that takes advantage of a peculiarity of the Apple IIe keyboard—two keys with apple symbols on either side of the space bar. Depressing one of those keys initiates a search for the next letter or combination of letters entered; you can abort the search by typing a short string of gibberish. The right key searches forward; the left one moves backward.

The SwyftCard interfaces smoothly to the IIe's Applesoft BASIC interpreter. You enter programs as raw text. You highlight the program text as you would for any word-processing block operation, press one command key, and the program executes. BASIC can also be used as a shortcut for some text manipulations. For example, you can store boilerplate phrases or paragraphs as string variables. Typing the variable name, marking it, and executing it recalls the stored text; retyping or complex copying operations are replaced by a few keystrokes. You follow similar mark-and-execute procedures for calculating numeric expressions in text and for setting printer and telecommunications parameters.

You do the same to dial the modem. Once you are connected, the text of your on-line session is incorporated into the scroll. If the modem is set to auto-answer, the SwyftCard will act as a rudimentary bulletin board—it will accept an incoming text stream. If you are at the keyboard, the card stores the message without interrupting your work.

Priced at $89.95, the SwyftCard package contains the card itself, self-adhesive labels for the nine command keys, a manual, a schematic diagram and theory of operation, a tutorial disk, and a utility to convert SwyftCard files to Apple ProDOS format.

Contact Information Appliance Inc., 530 University Ave., Palo Alto, CA 94301, (415) 328-5160.

—*Ezra Shapiro*

Inquiry **600.**

(continued)

Spreadsheet Bridges 1-2-3, dBASE

VP-Planner from Paperback Software is an integrated spreadsheet/database manager for the IBM PC and compatible computers. Its basic command set, macro capability, and data structure are compatible with Lotus 1-2-3; VP-Planner can process files prepared with 1-2-3 and make use of spreadsheet templates developed for that program. VP-Planner can also import or export data as dBASE II or dBASE III files without any special conversion.

VP-Planner stores logical operations and formulas as spreadsheet macros—data can be saved by choosing the most efficient format. The program uses sparse matrix technology to optimize memory use (empty cells or data fields are essentially ignored; only active cells require full space in memory).

VP-Planner can organize data and logic from either database or spreadsheet files (or a combination) into what is called a multidimensional database. Up to five dimensions are supported. The spreadsheet acts as a window into two dimensions of the five. Thus, VP-Planner can perform complex sorts based on multiple criteria and can construct fully relational database joins.

The primary user interface is that of a spreadsheet. However, the grid can be used for entering, viewing, and editing database information (either multidimensional or dBASE) in a table format.

Written in FORTH, VP-Planner also features automatic recognition and use of 8087 and 80287 math coprocessors, a "learn" function that records keystrokes into macros, background printing of worksheets, zero-width columns, and password protection of databases.

Suggested retail price for VP-Planner will be $99.95, which does not include a graphics print program. No price has been announced for VP-Graphics, a companion product that will answer that need. According to the company, VP-Planner will be available in late September; release of VP-Graphics will follow shortly thereafter. [*Editor's note: This item was based on prerelease software and preliminary documentation. Final product specifications are subject to change.*]

Contact Paperback Software, 2612 Eighth St., Berkeley, CA 94710, (415) 644-2116.

Inquiry 601.

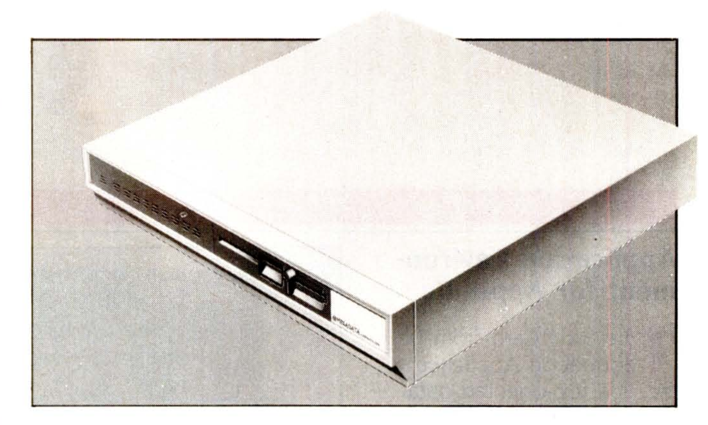
Corvus Cheetah Uses 68010

Corvus Systems' Cheetah workstation uses a 10-MHz Motorola 68010 processor and includes a 15-inch monitor with a resolution of 800 by 620 pixels and a 1-to-1 aspect ratio. Designed for computer-aided design, engineering, and electronic publishing applications, the Cheetah also features a 20-megabyte hard-disk drive, one 640K-byte floppy-disk drive, 1 megabyte of RAM, four RS-232C ports, one RS-422 port, and an Omninet local-area network port.

Standard software includes the UNIX System V operating system, a C compiler, a window display manager, and Corvus Connection network software. Up to 4 megabytes of RAM, additional mass-storage devices, and an optional floating-point math coprocessor can be added.

With the 20-megabyte hard disk and 1 megabyte of RAM, the Cheetah is priced at $9995. For additional information, contact Corvus Systems Inc., 2100 Corvus Dr., San Jose, CA 95124, (408) 559-7000.

Inquiry 602.



Megadata's Model Seven UNIX *system.*

8300 Model Seven UNIX Processor

Megadata's 8300 Model Seven uses the 68000 16-/32-bit microprocessor. The basic system features UNIX System V, 1 megabyte of RAM, a 26-megabyte Winchester disk, a 1-megabyte floppy-disk drive, and two RS-232C ports. This desktop computer is transportable.

An expansion board provides eight RS-232C ports and an additional 512K bytes or 1 megabyte of RAM for a maximum of 2 megabytes of system memory and eight users. Other options include increased disk capacity and streaming-tape backup.

The Model Seven sells for $4399. The expansion board adds from $650 to $990 to the basic system price, depending on amount of memory. Contact Megadata Corp., 35 Orville Dr., Bohemia, NY 11716, (516) 589-6800.

Inquiry 603.

HP Disks

Hewlett-Packard has introduced 10- and 20-megabyte hard-disk subsystems and a ¼-inch streaming-tape backup designed for IBM microcomputers and close compatibles as well as HP's own personal computers.

The HP 9154A 10-megabyte hard-disk drive stands 4⅕ inches high, runs 3½-inch platters, and has an average access time of 75 milliseconds. In addition, the drive has been modified to withstand shock and vibration, head and bearing assemblies have been redesigned, and the platter has been coated with a layer of sputtered carbon for added surface protection and lubrication. The HP 9134H 20-megabyte hard-disk drive stands 5⅕ inches high, runs 5¼-inch platters, and has an average access time of 85 milliseconds.

(continued)

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Inquiry 37 for End-Users. Inquiry 38 for DEALERS ONLY.

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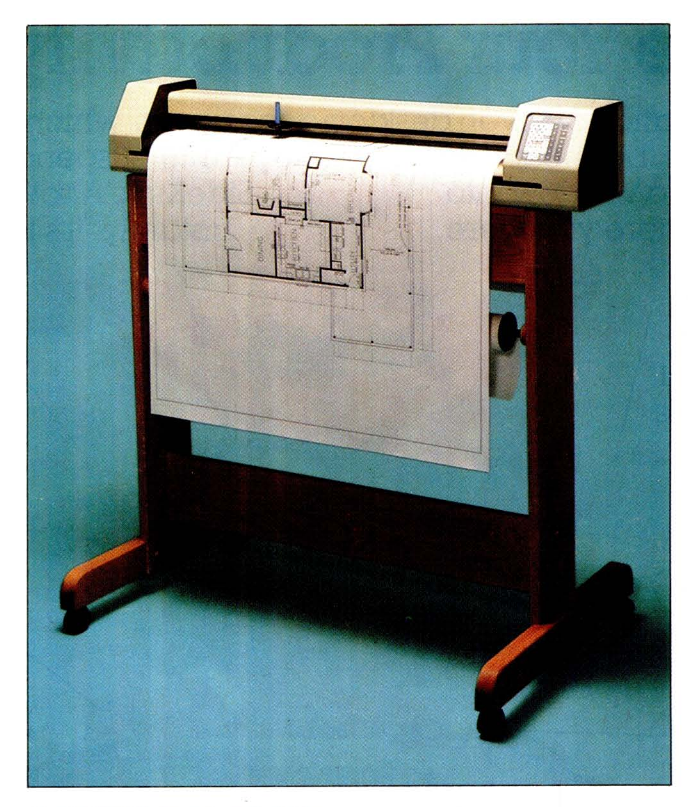
S15

The HP 9142A ¼-inch streaming-tape backup uses standard 15- and 60-megabyte cartridges, storing 2 megabytes of data per minute. The 15-megabyte cartridge has an average access time of 15 seconds; the 60-megabyte cartridge averages 45 seconds.

The PC/T format (Personal Computer/Tape, a registered trademark of Tallgrass Technologies Corporation) that HP has chosen is compatible with PC-DOS 2.0, 2.1, and 3.0, and MS-DOS 2.11. This lets you address files on tape with DOS commands. It also means that the backup unit can emulate a hard disk. In fact, you can boot DOS from the tape. Other PC/T features include selective backup and restore, off-line tape formatting, a media monitor that counts the number of times the tape is used, and the ability to partition a cartridge into one, two, or four volumes, each accessible by its own directory.

The drives can be hooked up to IBM personal computers and close compatibles via the HP 88500A interface kit. The kit includes a short-slot card, cables, and disk-utility software that can support up to seven hard disks and one tape backup.

The HP 9154A 10-megabyte drive is priced at $1690, the 9134H 20-megabyte drive is $2390, and the 9142A cartridge-tape backup is $1690. The 88500A interface kit is $199. Contact Inquiries Manager, Hewlett-Packard Co., 1820 Embarcadero Rd., Palo Alto, CA 94303 or your local Hewlett-Packard dealer.
Inquiry **604.**



The LP3700 large-format plotter.

Large-Format Plotter for Micros

IOLine Corporation's LP3700 Plotter, a large-format $4995 plotter, has twin RS-232C ports that let you use it in most microcomputer-based CAD/CAE environments. It can draw on any size media, continuously adjustable to full-size "E" (i.e., 36- by 48-inch) drawings.

Axial plotting is performed at 10 inches per second; diagonal plotting speed is 14 inches per second (maximum). Addressable resolution is 0.001 inch, 0.0025 inch, 0.1 mm, and 0.005 inch; mechanical resolution is 0.0025 inch. Repeatability is 0.0025 inch, or, with a pen change, 0.010 inch. The LP3700's buffer can accommodate 14,000 bytes (i.e., approximately 1500 vectors).

Operator controls include eight pen-move directions, selectable pen-move rates, chart-hold actuation, pen speed, chart size, and plot limits. Among the keyboard indicators are diagnostic test codes, plot out of limits, command error, and viewing/pause.

The LP3700's ASCII character set is resident within the plotter. Its parameters are 8 bits, no parity, and 2 stop bits at 300 to 9600 bps. Since the LP3700 emulates Houston Instrument's DMPL, it can be used with a wide wariety of available software. It can use both cut-sheet and roll-stock paper, vellum, matte polyester, mylar, or acetate film. The LP3700 can use such pens as Hewlett-Packard–compatible liquid inks, disposable fiber-tip pens, or roller balls. You can obtain custom pen adapters.

Oak and metal plotter stands are available. Contact IOLine Corp., Suite D1, 19417 36th Ave. W, Lynnwood, WA 98036, (206) 775-7861.
Inquiry **605.**

LISP Interpreter and Compiler

Levien Instrument Company has introduced a LISP interpreter, BYSO LISP 1.17, and a LISP compiler, BYSO LISP 2.17. The interpreter uses lexical binding, and the compiler supports both lexical and dynamic binding. All the features of version 1.17 are supported by 2.17.

BYSO LISP 1.17 features a full-screen editor, a structure editor that displays programs in graphics format, and six prettyprinting styles. Among its file- and library-management capabilities are open, close, define and save a library, read and write random-access files, read and write sequential characters, atoms, lists, and strings.

Data types include integers, multidimensional arrays, structures, and oblist. Such list-manipulation conventions as car, append, map functions, intersect, and remove are standard. Some of the control structures are cond, if, or, prog, return, let*, and apply.

BYSO LISP is compatible with LISP 1.5, MacLISP, and Common LISP. It's designed for the IBM PC and true work-alikes equipped with 256K bytes of memory.

BYSO LISP 1.17 is $150. Version 2.17 is $395. An upgrade for 1.17 is offered. Shipping and handling is $5 within the U.S. and $15 overseas. Contact Levien Instrument Co., Sittlington Hill, Box 31, McDowell, VA 24458.
Inquiry **606.**

(continued)

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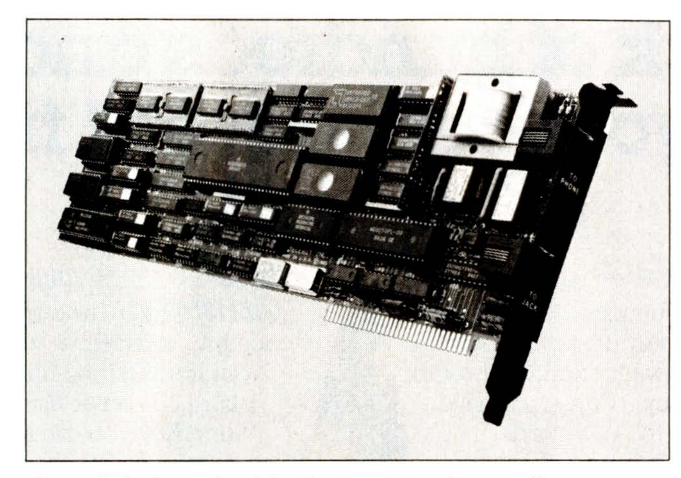
Modem Adapts to Phone Quality

Digital Communications Associates (DCA) and Telebit recently announced Irma's Fastlink, an intelligent, high-speed, packetized modem that transmits and receives data over ordinary dial-up phone lines at up to 10,000 bps. Telebit of Cupertino, CA, developed the patented technology for high-speed, error-free data communications using the concepts of packet switching, dynamic multicarrier modulation, and digital signal processing. DCA, an Alpharetta, GA, company that produces the Irma line of micro-to-mainframe communications devices, is marketing and distributing the modem; Telebit is manufacturing it.

The modem is available in two versions. As a plug-in board for the IBM PC, XT, AT, and compatibles, it costs $1995 and comes with Crosstalk-Fast from Microstuf. A stand-alone model is priced at $2395; Crosstalk-Fast is optional.

Both versions provide asynchronous, dial-up connection; automatic error detection and correction; automatic speed selection at time of connection; 300-bps and 1200-bps full-duplex modes for Bell 103 and 212A compatibility; real-time line analysis and adaptation; Adaptive Duplex for maximized throughput; self-test; call progress monitoring and reporting; auto-dial and auto-answer; and a superset of the Hayes command language.

When a Fastlink modem calls a standard 300- or 1200-bps modem, it adjusts to that speed and behaves as a like device. However, Telebit's Packetized Ensemble Protocol (PEP) allows two Fastlink modems (or other PEP devices) to communicate at speeds of 10,000 bps. When one Fastlink calls another, it analyzes phone-line quality to determine the maximum transmission speed.



The Fastlink plug-in board for the IBM PC and compatibles.



The stand-alone version of the Fastlink modem.

Fastlink works with a maximum of 512 carriers (every 8 Hz from 8 to 4000 Hz). The phone-line analysis tells which of those carriers is useful at any given time. Three modulation schemes are used to encode data. The lowest density is for low-quality carriers, and the highest density is for carriers with a high signal-to-noise ratio.

All of the hundreds of tones are then generated at the same time, converted through an inverse fast Fourier transform into a complex waveform, and sent as a packet to the other Fastlink. The packet is accompanied by a 16-bit cyclical redundancy check. If any error is detected, the packet is resent.

After each packet, the Fastlink again analyzes the signal-to-noise ratios on the carriers and reassesses the maximum transmission speed. The previous speed is set back or increased by between 50 and 100 bps.

Fastlink depends on 70,000 lines of code, a 10-MHz 68000, and a Texas Instruments TMS32010 digital signal processor for its processing speed and execution of PEP.

Crosstalk-Fast is a special version of Crosstalk-XVI. Besides high-speed file-transfer capability, it includes terminal-emulation features and access to Fastlink's phone-line analysis characteristics. Telebit has no plans to license PEP.

Contact DCA Inc., 1000 Alderman Dr., Alpharetta, GA 30201, (404) 442-4000.
Inquiry 607.

Interactive Satellite Dish

Equatorial Communications Company is offering the C-200, a small satellite dish designed specifically for personal computers and terminals. The C-200 dish, which measures 4 feet in diameter, can send and receive information at up to 19,200 bps; the dish connects to a personal computer through a standard RS-232C cable.

The C-200 transmits information over the weather-tolerant microwave band C to Equatorial Communications' transponders on the Westar IV and Galaxy III satellites. The information is then sent back to one of Equatorial's 36-foot dish receivers, processed on a mainframe computer, and retransmitted via satellite to another C-200.

The approximate cost for a C-200 setup is $6000, or about $225 per month, including charges for Equatorial's network services. The C-200 is designed primarily for large companies that use leased telephone lines. The minimum order is approximately 100 units. Contact Equatorial Communications Co., 300 Ferguson Dr., Mountain View, CA 94043, (415) 969-9500.
Inquiry 608.

(continued on page 431)

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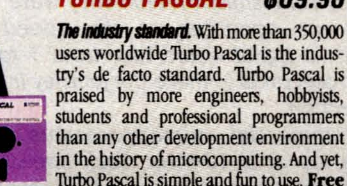
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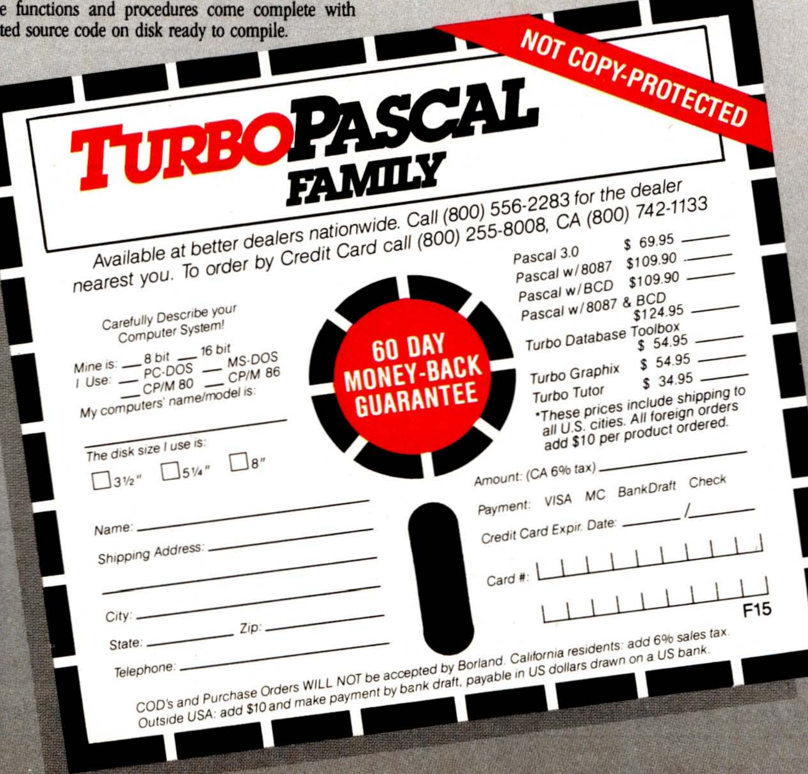


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A·S·K B·Y·T·E

Conducted by Steve Ciarcia

IN A CONSTELLATION FAR AWAY...

Dear Steve,

The reason I am writing to you is because for the last three years a friend of mine and I have been designing the plans for the most elaborate starship ever built. To give you an example of the immenseness of this ship, here are a few of its dimensions:

length: 2 miles
height: 1 mile
width: ½ mile
gross deadweight in metric tonnage: 1,500,000–2,000,000
number of main engines: six ion drives
backup: four cyclotron drives
impulse: 12 matter/antimatter drives
auxiliary power: 1500 fuel cells
number of decks: 373, from 0 (deck observation) to 372 (laser weaponry)

Our problem is that we are going to build our own computer and electrical layout of the ship. I have enclosed a block diagram of the computer as we need it (see figure 1). If you could give us any help, advice, or steer us to either books or people who could assist us, it would be greatly appreciated.

SEAN F. MCCARTNEY
Newton, KS

Your starship plans are very impressive. I congratulate you and your friend on your ambitions. Ad astra per aspera. [Editor's note: For those of you whose knowledge of Latin is as nonexistent as mine, that translates as "to the stars by hard ways," and it is the motto of Kansas.]

On a less grand scale than yours, some people have already projected some of the computing needs of an old-style starship like the USS Enterprise. *Check out the December 1977 BYTE for an article called "The Computer of Star Trek" by Kurt J. Schmucker and Robert M. Tarr (page 12).*

Any contracts that I may or may not have with certain unnamed agencies for which I consult may expressly forbid me to pass along any specific information regarding starship computer systems on which I may or may not be working. However, I would not be forbidden to point out some general considerations that may be of interest to you.

While a centralized computer system has advantages in coordinating information from all over the ship, some serious problems must be overcome. Due to the ship's size, information from a sensor (or another computer) may have to travel up to two miles to reach the main computer. Even if transmission efficiency were 100 percent—operating at the speed of light—a signal would take from 5 to 10 microseconds to make the journey in one direction.

Commercial microprocessors now operate at a 10-MHz clock speed, so perhaps we could surmise that seventh-

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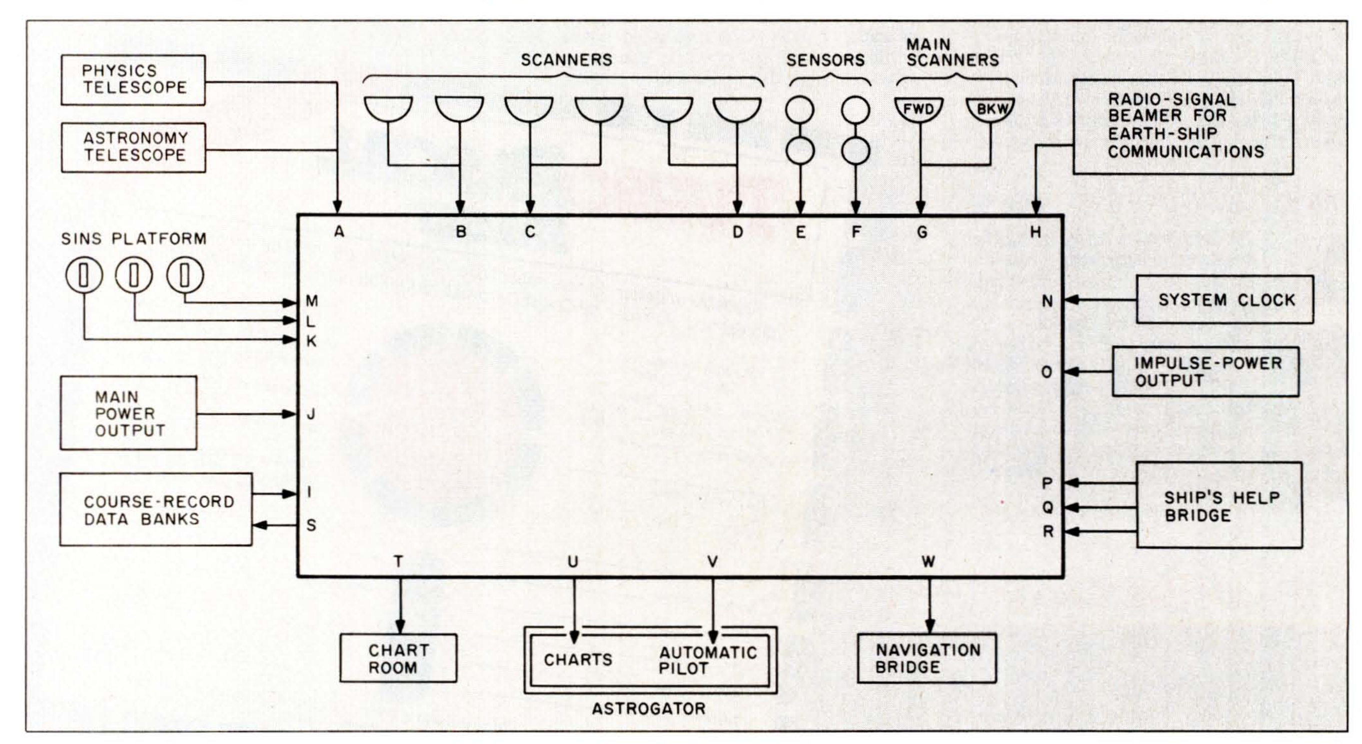


Figure 1: A *block diagram of Sean F. McCartney's computer for his proposed starship.*

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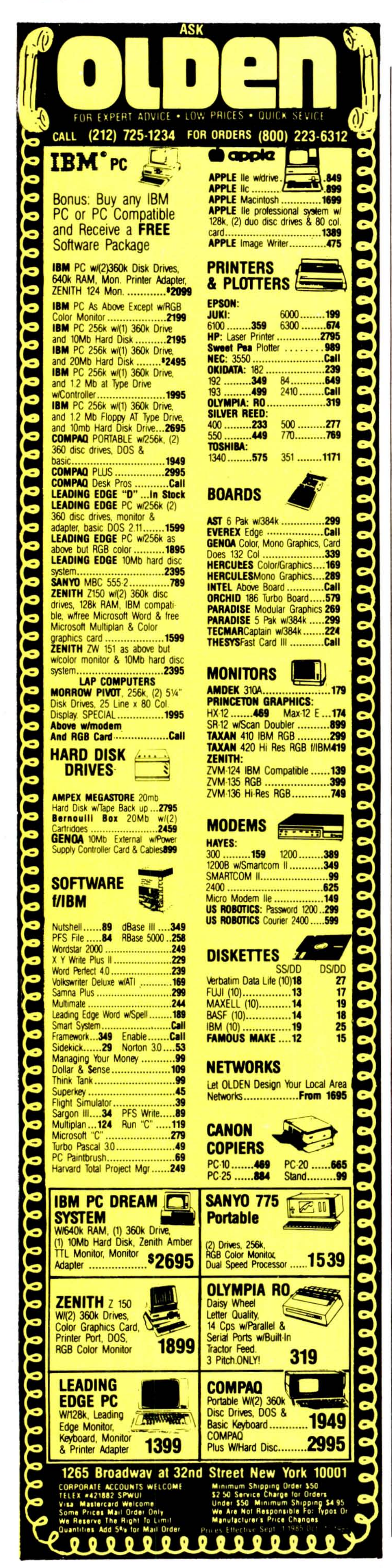
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and eighth-generation computers (we are just designing fifth-generation computers now) would have a clock speed of 100 MHz or greater with parallel processors. This would mean that the central computer was capable of operating so fast that the 5–10-µs delay would be a very long time indeed. Even if it could act upon the information in a picosecond or two, it would still face the same 5–10-µs propagation delay in responding. It is as if you put your hand on a hot stove, and it took 5 minutes for the pain signal to get to your brain. Your brain could decide to move your hand in less than a second, but it would take another 5 minutes for the signal to reach your hand and pull it away. By that time, you would have been in trouble for 10 minutes!

It would thus appear that a central computer system would demand that all high-priority operation systems be within reasonable proximity—no more than 100 feet. Another alternative would be to have local computers in control of their own systems but also be in a local-area network (star topology preferred) in order to receive less time-crucial information from other, farther-away, computers.

One other possibility comes to mind. About 30 years ago, Isaac Asimov wrote a paper titled "The Endochronic Properties of Resublimated Thiotimoline," in which he described a chemical compound that dissolved a fraction of a second before it was added to water. This was due to one of the chemical bonds being in the fourth dimension, giving temporal instability to the compound. If thiotimoline can be made to act as a semiconductor, the propagation-delay problem would be solved. It would then be possible for the central computer to be synchronized to its peripheral units no matter how close or far away they were. By cascading several thiotimoline-based circuits in series, you could effectively reduce the propagation delay to zero and have the central computer act upon the virtual information sent from the peripheral device immediately. When the actual signal was received 5–10 µs later, it could be relegated to the bit bucket because the central computer would already have responded! Naturally, the same circuitry would be used in the opposite direction as well.

Of course, all this hinges upon making semiconductor devices from thiotimoline. As I recall, Dr. Asimov had some reservations about the use of this compound, and he is the only chemist I know of who has synthesized it. Perhaps you could contact him and find out what the status of thiotimoline is. If you find out, let me know.

Good luck with your project.—Steve

P.S. I checked again to see that you were writing to me and not Pournelle.

S-100 Emulator Boards

Dear Steve,

It seems that many types of add-on boards for Apple and IBM computers are available. I was wondering if any of these boards allow S-100 bus computers to run Apple and IBM software?

I would like such boards for my CompuPro 8/16, since I would like to try many programs for the Apple and IBM.

Lee Siddoway
Kure, Japan

I agree with you that S-100 Apple and IBM cards are a good idea. Unfortunately, up to now no one has offered them. There have been S-100 boards that use the 6502 processor (as does the Apple) but without the necessary video or disk-controller circuitry to emulate the Apple. No one currently manufactures an S-100 Apple board as far as I know.

Fortunately for you, Viasyn will soon be releasing an S-100 board to allow your CompuPro 8/16 to look more like an IBM, run PC-DOS, and read PC-DOS disks. Check with your local dealer or write Viasyn directly. Again, no other manufacturer I know has plans for an IBM S-100 card.—Steve

Radio Shack PC-3

Dear Steve,

I recently purchased a Radio Shack PC-3 pocket computer. Because I want to program it in machine language, I would like to know what microprocessor it has and where I can find information about it.

The PC-3's BASIC has the PEEK and POKE commands, but it is missing the USR function necessary to run a machine-language program. How could I get around this problem?

Also, the computer has a dot-matrix printer. Is it possible to write a machine-language program to produce graphics on the printer?

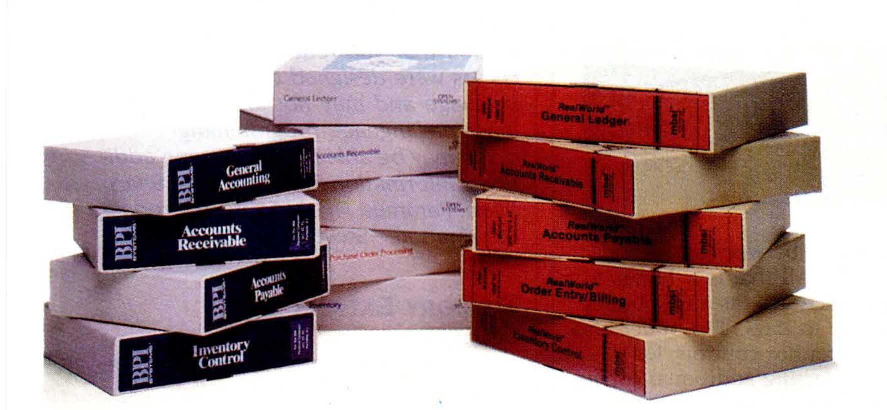
Ralf-Eric Pieper
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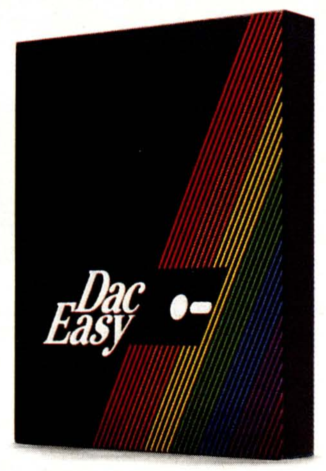
Sharp Corporation has chosen to keep the technical specifications of its PC-1250 pocket computer (the same as the Radio

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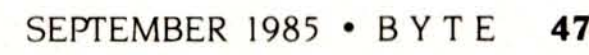
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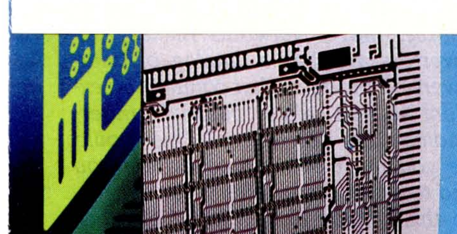
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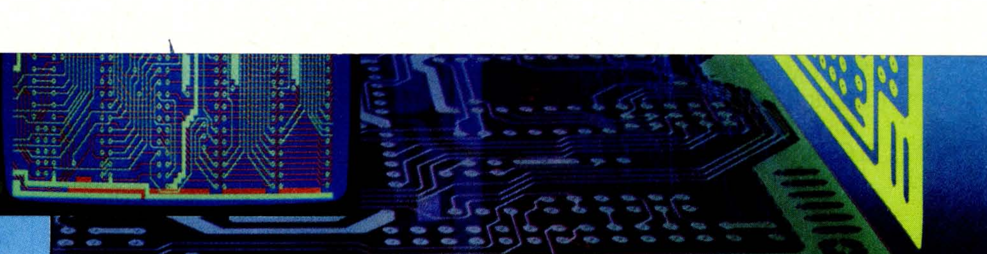
Minimum Hardware Requirements:
IBM (PCjr, PC, XT, or AT)[1] or other compatibles. 128K memory, one 5¼ DSDD floppy disk, 132 column printer in compressed mode, 80X24 CRT, MS-DOS[2], PC DOS[1] 2.0 or later.

[1]Trademarks of International Business Machines Corporation.
[2]Trademark of Microsoft Corporation.



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Shack PC-3) unpublished, and to date there has been no mention of the information that you requested. These machines were designed to use the BASIC language and may not allow access to machine-language programming.

You may be able to obtain some additional information from Sharp, 10 Sharp Plaza, Paramus, NJ 07652, Attn: Product Information.—Steve

Memory Expansion

Dear Steve,

I have two questions that may also be of interest to many of your readers. First, do you know of any memory-expansion device of at least 16K bytes that will plug into my TRS-80 PC-2? Second, what would be the best way for me to increase the memory of my TI-99/4A from 16K to 64K bytes now that no TI factory expansion devices are available?

Ed Rockwood
Portland, OR

EPROMs for software.

Could you please point me in the direction of some reference materials that I could study, especially some information on the 8237?

Jay Shree
Cambridge, MA

The hardest part of any hardware design is developing the logic necessary to execute each function. The next step is to select the chips that will accomplish each function. It's then just a matter of connecting these chips together with some TTL "glue."

It appears that you have already gone through these steps, as you have already selected your ICs for the project. Since all the chips are from Intel, its data catalog will be of great help. The Intel data catalog gives complete chip specifications and pin-outs and shows sample circuits. Contact Intel Corporation, Literature Department SV3-3, 3065 Bowers Ave., Santa Clara, CA 95051.

The Intel catalog also contains a good description of the operation of the 8237 DMA controller, which will show you how it is used in a circuit with the 8085.

You can obtain information about your A/D converter from its manufacturer. For example, Micro Networks makes A/D converters and has a catalog of data-conversion products that contains an excellent section called "Tutorial: Understanding Data Converters." This should give you most of the information you need to use A/D converters. You can obtain this catalog from Micro Networks,

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7400

Part No.	Pins	Price
SN7400N	14	.29
SN7401N	14	.29
SN7402N	14	.29
SN7403N	14	.29
SN7404N	14	.35
SN7405N	14	.49
SN7406N	14	.59
SN7407N	14	.59
SN7408N	14	.29
SN7409N	14	.35
SN7410N	14	.29
SN7411N	14	.29
SN7412N	14	.49
SN7413N	14	.39
SN7414N	14	.49
SN7416N	14	.49
SN7417N	14	.59
SN7420N	14	.19
SN7421N	14	.59
SN7422N	14	.59
SN7423N	16	.69
SN7425N	14	.39
SN7426N	14	.39
SN7427N	14	.25
SN7428N	14	.59
SN7430N	14	.35
SN7432N	14	.39
SN7433N	14	.49
SN7437N	14	.25
SN7438N	14	.49
SN7439N	14	.79
SN7440N	14	.19
SN7441N	16	.89
SN7442N	16	.45
SN7443N	16	1.25
SN7444N	16	1.25
SN7445N	16	.69
SN7446N	16	.75
SN7447N	16	.75
SN7448N	16	.75
SN7454N	14	.19
SN7459N	14	.35
SN7460N	14	.39
SN7470N	14	.39
SN7472N	14	.39
SN7473N	14	.39

Part No.	Pins	Price
SN7474N	14	.39
SN7475N	16	.45
SN7476N	16	.39
SN7479N	14	4.95
SN7480N	14	.89
SN7482N	14	1.49
SN7483N	16	.55
SN7485N	16	.59
SN7486N	14	.39
SN7489N	16	2.25
SN7490N	14	.49
SN7491N	14	.79
SN7492N	14	.45
SN7493N	14	.45
SN7494N	14	.89
SN7495N	14	.49
SN7496N	16	.49
SN7497N	16	3.25
SN74100N	24	1.95
SN74105N	14	1.19
SN74107N	14	.29
SN74109N	16	.39
SN74116N	24	1.49
SN74121N	14	.45
SN74122N	14	.69
SN74123N	16	.55
SN74125N	14	.49
SN74126N	14	.49
SN74128N	14	.79
SN74132N	14	.59
SN74136N	14	.69
SN74141N	16	.89
SN74142N	16	3.95
SN74143N	24	3.95
SN74144N	24	3.95
SN74145N	16	.65
SN74147N	16	1.29
SN74148N	16	.89
SN74150N	24	1.49
SN74151N	16	.49
SN74152N	14	.49
SN74153N	16	.99
SN74154N	24	1.49
SN74155N	16	.49
SN74156N	16	.59
SN74157N	16	.49

Part No.	Pins	Price
SN74159N	24	1.95
SN74160N	16	.59
SN74161N	16	.59
SN74162N	16	.59
SN74163N	16	.59
SN74164N	14	.69
SN74165N	16	.69
SN74166N	16	.69
SN74167N	16	2.95
SN74170N	16	1.59
SN74172N	24	4.95
SN74173N	16	.85
SN74174N	16	.59
SN74175N	16	.59
SN74176N	14	.79
SN74177N	14	.79
SN74179N	16	1.49
SN74180N	14	.69
SN74181N	24	1.95
SN74182N	16	1.05
SN74184N	16	2.29
SN74185N	16	2.29
SN74190N	16	.69
SN74191N	16	.69
SN74192N	16	.69
SN74193N	16	.69
SN74194N	16	.69
SN74195N	16	.49
SN74196N	14	.75
SN74197N	14	.75
SN74198N	24	1.19
SN74199N	24	1.19
SN74221N	16	1.19
SN74251N	16	.79
SN74273N	20	1.95
SN74276N	20	2.49
SN74279N	16	.79
SN74283N	16	1.39
SN74284N	16	2.95
SN74285N	16	2.95
SN74365N	16	.55
SN74366N	16	.55
SN74367N	16	.55
SN74368N	16	.55
SN74390N	16	1.49
SN74393N	14	1.49

74LS

Part No.	Pins	Price
74LS00	14	.29
74LS01	14	.29
74LS02	14	.35
74LS03	14	.29
74LS04	14	.39
74LS05	14	.35
74LS06	14	.99
74LS07	14	.99
74LS08	14	.35
74LS09	14	.35
74LS10	14	.35
74LS11	14	.35
74LS14	14	.59
74LS20	14	.29
74LS21	14	.35
74LS26	14	.29
74LS27	14	.35
74LS28	14	.39
74LS30	14	.39
74LS32	14	.39
74LS37	14	.35
74LS38	14	.39
74LS42	16	.49
74LS47	16	.89
74LS51	14	.29
74LS73	14	.39
74LS74	14	.49
74LS75	16	.45
74LS76	16	.39
74LS85	16	.89
74LS86	14	.39
74LS90	14	.55
74LS92	14	.55
74LS93	14	.59
74LS96	16	.89
74LS107	14	.39
74LS109	16	.39
74LS112	16	.45
74LS122	14	.49
74LS123	16	.79
74LS125	14	.59
74LS126	14	.59

Part No.	Pins	Price
74LS132	14	.65
74LS133	16	.59
74LS136	14	.39
74LS138	16	.59
74LS139	16	.59
74LS145	16	1.19
74LS147	16	1.95
74LS148	16	1.79
74LS151	16	.59
74LS153	16	.59
74LS154	24	1.49
74LS155	16	.69
74LS156	16	.69
74LS157	16	.69
74LS158	16	.59
74LS160	16	.69
74LS161	16	.69
74LS162	16	.69
74LS163	16	.69
74LS164	14	.89
74LS165	16	.89
74LS168	16	1.19
74LS169	16	1.49
74LS170	16	1.49
74LS173	16	.69
74LS174	16	.69
74LS175	16	.69
74LS181	24	2.49
74LS190	16	.79
74LS191	16	.89
74LS192	16	.79
74LS193	16	.89
74LS194	16	.69
74LS195	16	.59
74LS196	14	.89
74LS197	14	.89
74LS221	16	1.09
74LS240	20	1.09
74LS241	20	.99
74LS243	14	1.09

Part No.	Pins	Price
74LS244	20	1.29
74LS245	20	1.49
74LS251	16	.59
74LS253	16	.59
74LS257	16	.59
74LS258	16	.59
74LS260	14	.59
74LS266	14	.49
74LS273	20	1.49
74LS279	16	.49
74LS280	14	1.95
74LS299	20	2.95
74LS322	20	3.95
74LS323	20	3.95
74LS347	16	.79
74LS353	16	1.09
74LS364	20	1.95
74LS365	16	.49
74LS366	16	.49
74LS367	16	.49
74LS368	16	.49
74LS373	20	1.49
74LS374	20	1.49
74LS375	16	.69
74LS386	14	.39
74LS393	14	1.19
74LS399	16	1.49
74LS490	16	1.95
74LS533	20	1.95
74LS534	20	1.95
74LS540	20	1.49
74LS541	20	1.49
74LS640	20	2.19
74LS641	20	2.19
74LS644	20	2.19
74LS645	20	2.19
74LS670	16	1.49
74LS688	20	2.95
81LS95	20	1.49
81LS96	20	1.49
81LS97	20	1.49
81LS98	20	1.49

74S/PROMS*

Part No.	Pins	Price
74S00	14	.35
74S02	14	.35
74S04	14	.45
74S05	14	.45
74S08	14	.45
74S09	14	.39
74S10	14	.35
74S11	14	.35
74S15	14	.35
74S20	14	.35
74S22	14	.35
74S30	14	.35
74S32	14	.45
74S37	14	.99
74S38	14	.89
74S64	14	.39
74S65	14	.39
74S74	14	.55
74S85	16	1.99
74S86	14	.55
74S112	16	.55
74S124	16	2.75

Part No.	Pins	Price
74S132	14	1.89
74S133	16	.45
74S135	16	.89
74S136	14	1.39
74S138	16	.89
74S139	16	.89
74S140	14	.69
74S151	16	.99
74S153	16	.99
74S157	16	.99
74S158	16	.99
74S160	16	2.29
74S169	16	4.29
74S174	16	1.09
74S175	16	1.09
74S188*	16	1.75
74S194	16	1.49
74S195	16	1.49
74S196	14	1.49
74S240	20	1.95

Part No.	Pins	Price
74S241	20	1.95
74S242	14	2.19
74S244	20	2.19
74S251	16	.99
74S253	16	.99
74S257	16	.99
74S258	16	.99
74S273	20	2.39
74S280	14	1.89
74S287*	16	1.79
74S288*	16	1.79
74S299	20	5.95
74S373	20	2.49
74S374	20	2.49
74S387*	16	1.95
74S471*	20	4.95
74S472*	20	4.95
74S473*	20	4.95
74S570*	16	2.95
74S571*	16	2.95
74S572*	18	4.95
74S573*	18	4.95

74ALS

Part No.	Pins	Price
74ALS00	14	.59
74ALS02	14	.59
74ALS04	14	.59
74ALS08	14	.59
74ALS10	14	.59
74ALS30	14	.59
74ALS32	14	.65
74ALS74	14	.79
74ALS109	16	.79
74ALS112	16	.69
74ALS138	16	1.25
74ALS240	20	2.25
74ALS244	20	2.25
74ALS245	20	2.59
74ALS373	20	2.59
74ALS374	20	2.59

74F

Part No.	Pins	Price
74F00	14	.69
74F02	14	.75
74F04	14	.89
74F08	14	.75
74F10	14	.75
74F20	14	.69
74F32	14	.79
74F74	14	.85
74F86	14	1.15
74F109	16	.95
74F138	16	1.69
74F139	16	1.49
74F157	16	1.69
74F158	16	1.69
74F240	20	3.75
74F244	20	3.49
74F253	16	1.79
74F257	16	1.79
74F280	14	1.69
74F373	20	4.89
74F374	20	4.59
74F379	16	1.99

CD—CMOS

Part No.	Pins	Price
CD4000	14	.29
CD4001	14	.29
CD4002	14	.29
CD4006	14	.89
CD4007	14	.29
CD4008	16	.89
CD4009	16	.59
CD4010	16	.49
CD4011	14	.29
CD4012	14	.29
CD4013	14	.39
CD4014	16	.89
CD4015	16	.39
CD4016	14	.49
CD4017	16	.79
CD4018	16	.79
CD4019	16	.49
CD4020	16	.75
CD4021	16	.75
CD4022	16	.75
CD4023	14	.29
CD4024	14	.69
CD4025	14	.29
CD4026	16	1.59
CD4027	16	.45
CD4028	16	.69
CD4029	16	.79
CD4030	14	.39
CD4034	24	1.79
CD4035	16	.79
CD4040	16	.75

Part No.	Pins	Price
CD4041	14	.69
CD4042	16	.69
CD4043	16	.79
CD4044	16	.79
CD4046	16	.89
CD4047	14	.89
CD4048	16	.59
CD4049	16	.39
CD4050	16	.39
CD4051	16	.79
CD4052	16	.89
CD4053	16	.79
CD4056	16	2.95
CD4059	24	3.95
CD4060	16	.89
CD4066	14	.45
CD4068	14	.39
CD4069	14	.35
CD4070	14	.29
CD4071	14	.29
CD4072	14	.29
CD4073	14	.29
CD4075	14	.29
CD4076	16	.89
CD4077	14	.35
CD4078	14	.49
CD4081	14	.29
CD4093	14	.49
CD4094	16	1.95
CD4098	16	1.95
CD4099	16	1.89

Part No.	Pins	Price
CD40103	16	2.49
CD4503	16	.69
CD4506	16	1.29
CD4507	14	1.19
CD4508	24	1.95
CD4510	16	.85
CD4511	16	.85
CD4512	16	.85
CD4514	24	1.49
CD4515	24	1.49
CD4516	16	.89
CD4518	16	.89
CD4519	16	.59
CD4520	16	.89
CD4522	16	1.69
CD4526	16	1.19
CD4528	16	1.19
CD4529	16	1.69
CD4531	16	.89
CD4538	16	1.49
CD4541	14	1.49
CD4543	16	1.19
CD4553	16	4.95
CD4566	16	2.95
CD4583	16	2.49
CD4584	14	.59
CD4585	16	1.39
CD4723	16	1.19
CD4724	16	1.19
MC14410	16	8.95
MC14411	24	11.95
MC14412	16	7.95
MC14433	24	17.95
MC14490P	16	4.95
MC14572	16	1.19

RED-HOT RAM & EPROM PRICES

Part No.	Description	Price
21C14	(200ns) CMOS SRAM CMOS USES LESS POWER	.99
27C16	(450ns) CMOS EPROM	9.95
4164N-200	(DRAM)	9/9.95
6116P-4	(200ns) SRAM	3.49
6116LP-4	(200ns) L.P. SRAM	3.69
6264LP-15	(150ns) L.P. SRAM	7.49
MC146818	REAL TIME CLOCK & RAM	7.95
27128-25	(250ns) EPROM	5.95
41256-150	(150ns) DRAM	6.49
68764	(450ns) 21V EPROM	12.95
68766	(350ns) 25V EPROM	14.95

MICROPROCESSOR COMPONENTS

MICROPROCESSOR CHIPS

Part No.	Pins	Function	Price
D765AC	40	Floppy Disk Controller	16.95
D3242	28	Addr. Multiplexer & Refresh Counter	7.95
TMS5501	40	Synchronous Data Interface (SIRC)	14.95
Z80, Z80A, Z80B, Z8000 SERIES			
Z80	40	CPU (MK3880N)(780C) 2.5MHz	2.75
Z80-CTC	28	Counter Timer Circuit	3.49
Z80-DART	40	Dual Asynchronous Rec./Trans.	8.95
Z80-DMA	40	Direct Memory Access Circuit	12.49
Z80-P10	40	Parallel I/O Interface Controller	2.95
Z80-S10/0	40	Serial I/O (TxCB and RxCB Bonded)	11.49
Z80-S10/1	40	Serial I/O (Lacks DTRB)	11.49
Z80-S10/2	40	Serial I/O (Lacks SYNCB)	11.49
Z80-S10/9	40	Serial I/O	11.49
Z80A	40	CPU (MK3880N-4)(780C-1) 4MHz	2.95
Z80A-CTC	28	Counter Timer Circuit	3.95
Z80A-DART	40	Dual Asynchronous Rec./Trans.	9.95
Z80A-DMA	40	Direct Memory Access Circuit	12.95
Z80A-P10	40	Parallel I/O Interface Controller	3.95
Z80A-S10/0	40	Serial I/O (TxCB and RxCB Bonded)	11.95
Z80A-S10/1	40	Serial I/O (Lacks DTRB)	11.95
Z80A-S10/2	40	Serial I/O (Lacks SYNCB)	11.95
Z80A-S10/9	40	Serial I/O	11.95
Z80B	40	CPU (MK3880N-6) 6MHz	8.95
Z80B-CTC	28	Counter Timer Circuit	11.95
Z80B-DART	40	Dual Asynchronous Rec./Trans.	19.95
Z80B-P10	40	Parallel I/O Interface Controller	10.95
6500/6800/68000 SERIES			
6502	40	MPU with Clock (1MHz)	4.95
6502A	40	MPU with Clock (2MHz)	5.25
6502B	40	MPU with Clock (3MHz)	7.95
6520	40	Peripheral Inter. Adapter	2.75
6522	40	Versatile Inter. Adapter	4.95
6551	28	Async. Comm. Interface Adapt.	6.95
6800	40	MPU	2.95
6802	40	MPU with Clock and RAM	5.95
6809	40	CPU — 8-Bit (On-Chip Oscillator)	6.95
6809E	40	CPU — 8-Bit (External Clocking)	8.49
68B09E	40	CPU — 8-Bit (Ext. Clocking) 2MHz	11.49
6810	24	128x8 Static RAM	2.75
68B10	24	128x8 Static RAM (2MHz)	5.95
6821	40	Peripheral Inter. Adapt (MC6820)	2.75
68B21	40	Peripheral Interface Adapter (2MHz)	4.95
6845	40	CRT Controller (CRTC)	9.95
68B45	40	CRT Controller (CRTC) 2MHz	14.95
6850	24	Asynchronous Comm. Adapter	2.95
6860	24	0-600bps Digital MODEM	6.95
68000L8	64	MPU 16-Bit (8MHz)	19.95
68488P	40	General Purpose Int. Adapter	9.95
68661	28	Enhanced Prog. Comm. Interface (2661)	8.95
8000/80000 SERIES			
8031	40	Control Oriented CPU w/RAM & I/O	12.95
8035	40	MPU — 8-Bit	4.95
8039	40	CPU—Sgl. Chip 8-Bit (128bts. RAM)	4.95
8060	40	CPU — 8-Bit NMOS	12.95
8073N	40	CPU w/Basic Micro Interpreter	29.95
8080A	40	CPU	3.95
8085A	40	CPU	3.95
8085A-2	40	CPU-8-Bit N-Channel (5MHz)	10.95
8086-2	40	CPU 16-bit 8MHz	19.95
8087	40	Arithmetic Processor (5MHz)	119.00
8087-2	40	Arithmetic Processor (8MHz)	125.00
8088	40	CPU 8/16-Bit	14.95
8116	18	Dual Baud Rate Generator	9.49
8155	40	HMOS RAM I/O Port-Timer	4.95
8156	40	RAM with I/O Port and Timer	5.95
8202	40	Dynamic RAM Controller	19.95
8203	40	64K Dynamic RAM Controller	29.95
8205	16	Hi Speed 1 out of 8 Binary Decoder	3.95
8212	24	8-Bit Input/Output (74S412)	2.25
8224	16	Clock Generator/Driver	2.19
8228	28	Sys. Cont./Bus Driver (74S428)	3.95
8237-5	40	High Perf. Prog. DMA Cont. (5MHz)	12.95
8238	28	System Controller (74S438)	4.95
8243	24	I/O Expander for 48 Series	3.95
8250A	40	Async. Comm. Element	9.95
8250B	40	ACE (IBM PC or XT Software Compatible)	10.95
8251	28	Prog. Comm. I/O (USART)	3.25
8251A	28	Prog. Comm. Interface (USART)	3.49
8253-5	24	Prog. Interval Timer	6.49
8254	24	Programmable Interval Timer	13.49
8255	40	Prog. Peripheral I/O (PPI)	3.95
8255A-5	40	Prog. Peripheral I/O (PPI) 5MHz	4.25
8257-5	40	Prog. DMA Controller	6.95
8259	28	Prog. Interrupt Control	5.95
8259-5	28	Prog. Interrupt Controller	6.95
8272	40	Sgle/Dble Density Floppy Disk Cont.	16.95
8274	40	Multi-Protocol Serial Cont. (7201)	14.95
8275	40	Prog. CRT Controller	14.95
8279	40	Prog. Keyboard/Display Interface	5.49
8279-5	40	Prog. Keyboard/Display Interface	5.95
8282	20	Octal Latch	6.49
8284	18	Clock Generator/Driver	5.49
8286	20	Octal Bus Transceiver	6.49
8287	20	Octal Bus. Transceiver (Inverted)	6.49
8288	20	Bus Controller	13.95
8289	20	Bus Arbiter	24.95
8741	40	8-Bit Univ. Peripheral Interface	19.95
8748	40	HMOS EPROM MPU	19.95
8749	40	MPU 8-Bit (EPROM Version of 8049)	19.95
8751	40	CPU w/4Kx8 EPROM & 128x8 RAM	29.95
8755	40	16K EPROM with I/O	19.95
80186	68	High Integration 16-Bit MPU	19.95
80188	68	High Integra. 16-Bit MPU (8-Bit Data Bus)	19.95
80287	40	Numeric Processor Ext.	195.00
SPECIAL FUNCTION			
MC3470P	18	Floppy Disk Read Amp System	4.95
MM5321N	16	TV Camera Sync. Generator	9.95
MM58167AN	24	Microprocessor Real Time Clock	8.95
MM58174AN	16	Micro. Compatible Time Clock	8.95
MM5369AA/N	8	Prog. Oscillator/Divider (60Hz)	1.79
MM5369EST	8	Prog. Oscillator/Divider (100Hz)	1.95
MC146818	24	Real-Time Clock Plus RAM	7.95

DYNAMIC RAMS

Part No.	Pins	Function	Price
1103	18	1024x1 (300ns)	.99
4027	16	4096x1 (250ns)	1.49
4116N-15	16	16,384x1 (150ns)	1.39 — 8/10.95
4116N-20	16	16,384x1 (200ns)	.79-8/6.29
4116N-25	16	16,384x1 (250ns)	.69-8/5.49
4164N-150	16	65,536x1 (150ns)	1.22-9/10.95
4164N-200	16	65,536x1 (200ns)	1.11-9/9.95
MM5261	18	1024x1 (300ns)	.35 — 8/1.95
MM5262	22	2048x1 (365ns)	.35 — 8/1.95
MM5270	18	4096x1 (250ns)	4.95
MM5280	22	4096x1 (200ns) 2107	3.95
MM5298-3	16	8192x1 (200ns)	.59
8118	16	16,384x1 (120ns) (+5V Only Req.)	.99
41256-150	16	262,144x1 (150ns)	6.49
41256-200	16	262,144x1 (200ns)	5.95
4128	16	131,072x1 (250ns)	8.95
STATIC RAMS			
2101	22	256x4 (450ns) 8101	1.95
2102	16	1024x1 (350ns)	.89
2102-2L	16	1024x1 (250ns) L.P. (91L02)	1.49
2111	18	256x4 (450ns) 8111	2.49
2112	16	256x4 (450ns) MOS	2.49
2114N	18	1024x4 (450ns)	1.29 — 8/9.95
2114N-L	18	1024x4 (450ns) L.P.	1.65 — 8/12.95
2114N-2	18	1024x4 (200ns)	1.39 — 8/10.95
2114N-2L	18	1024x4 (200ns) L.P.	1.69 — 8/13.49
2147HN	18	4096x1 (70ns)	4.49
2148HN	18	1024x4 (70ns)	4.95
TMS4045	18	1024x4 (450ns)	3.95
TMS40L47-45	20	1024x4 (450ns)	1.95
5101	22	256x4 (450ns) CMOS	2.95
MM5257	18	4096x1 (450ns) 4044	4.95
HM6116P-2	24	2048x8 (120ns) CMOS	4.95
HM6116LP-2	24	2048x8 (120ns) L.P. CMOS	6.49
HM6116P-3	24	2048x8 (150ns) CMOS	3.75
HM6116LP-3	24	2048x8 (150ns) L.P. CMOS	3.95
HM6116P-4	24	2048x8 (200ns) CMOS	3.49
HM6116LP-4	24	2048x8 (200ns) L.P. CMOS	3.69
HM6264P-12	28	8192x8 (120ns) CMOS	7.25
HM6264LP-12	28	8192x8 (120ns) L.P. CMOS	7.95
HM6264P-15	28	8192x8 (150ns) CMOS	6.95
HM6264LP-15	28	8192x8 (150ns) L.P. CMOS	7.49
27LS00	16	256x1 (80ns) L.P.	3.95
7489	16	16x4 (50ns) 3101	2.25
74C921	18	256x4 (250ns) CMOS	5.95
74C930	18	1024x1 (250ns) CMOS (6518)	5.95
74S189	16	16x4 (35ns) 93405	2.95
74S289	16	16x4 (35ns) 3101	2.95
82S10	16	1024x1 (50ns) O.C. (93415)	3.95
82S25	16	16x4 (50ns) O.C. (74S289)	2.25
PROMS/EPROMS			
1702A	24	256x8 (1μs)	3.95
TMS2516	24	2048x8 (450ns)	4.95
TMS2532	24	4096x8 (450ns)	5.49
TMS2564	28	8192x8 (450ns)	10.95
2708	24	1024x8 (450ns)	3.95
TMS2716	24	2048x8 (450ns) 3 voltage	7.95
2716	24	2048x8 (450ns)	3.95
27C16	24	2048x8 CMOS	9.95
2716-1	24	2048x8 (350ns)	4.95
2716Q-5	24	2048x8 (550ns)	3.75
2732	24	4096x8 (450ns)	4.25
2732A-20	24	4096x8 (200ns) 21V	9.95
2732A-25	24	4096x8 (250ns) 21V	5.95
2732A-45	24	4096x8 (450ns) 21V	4.49
27C32	24	4096x8 CMOS	11.95
27C32A-30	24	4096x8 (300ns) 21V (CMOS)	22.95
2764-20	28	8192x8 (200ns) 21V	6.95
2764-25	28	8192x8 (250ns) 21V	5.09
2764A-25	28	8192x8 (250ns) 12.5V	5.95
2764-45	28	8192x8 (450ns) 21V	4.95
27C64	28	8192x8 CMOS 21V	11.95
27128-25	28	16,384x8 (250ns) 128K 21V	5.95
27128A-25	28	16,384x8 (250ns) 128K 12.5V	7.95
27256-25	28	32,768x8 (250ns) 256K (14V)	11.95
68764	24	8192x8 (450ns) 21V	12.95
68766	24	8192x8 (350ns) 25V	14.95
74S188	16	32x8 PROM O.C. (6330-1)	1.75
74S287	16	256x4 PROM T.S. (6301-1)	1.79
74S288	16	32x8 PROM T.S. (6331-1)	1.79
74S387	16	256x4 PROM O.C. (6300-1)	1.95
74S471	20	256x8 PROM T.S. (6309-1)	4.95
74S472	20	512x8 PROM T.S. (6349-1)	4.95
74S473	20	512x8 PROM O.C. (6348)	4.95
74S474	24	512x8 PROM T.S. (DM87S296N)	4.95
74S475	24	512x8 PROM O.C. (6340)	4.95
74S476	18	1024x4 PROM T.S.	6.95
74S478	24	1024x8 PROM T.S.	9.95
74S570	16	512x4 PROM O.C. (6305)	2.95
74S571	16	512x4 PROM T.S. (6306)	2.95
74S572	18	1024x4 PROM O.C. (6352)	4.95
74S573	18	1024x4 PROM T.S. (82S137)	4.95
82S23	16	32x8 PROM O.C. (27S18)	2.95
82S115	24	512x8 PROM T.S. (27S15)	9.95
82S123	16	32x8 PROM T.S. (27S19)	2.95
82S126	16	256x4 PROM O.C. (27S20)	2.95
82S129	16	256x4 PROM T.S. (27S21)	2.95
82S130	16	512x4 PROM O.C. (27S12)	3.95
82S185	18	2048x4 PROM T.S. (TBP24S81)	9.95
82S191	24	2048x8 (80ns)	14.95
DM87S181N	24	1024x8 PROM T.S. (82S181)	9.95
DATA ACQUISITION			
DC10		Mostek DC/DC Converter +5V to −9V	2.95
ADC0801	20	8-Bit A/D Converter (1/4LSB)	14.95
ADC0803	20	8-Bit A/D Converter (±1/2LSB)	4.95
ADC0804	20	8-Bit A/D Converter (1LSB)	3.49
ADC0808	28	8-Bit A/D Conv. w/8-Channel Analog	9.95
ADC0809	28	8-Bit A/D Converter (8-Ch. Multi.)	4.49
ADC0816	40	8-Bit A/D Conv. w/16-Channel Analog	14.95
ADC0817	40	8-Bit A/D Converter (16-Ch. Multi.)	9.49
DAC0806	16	8-Bit D/A Converter (0.78% Lin.)	1.95
DAC0807	16	8-Bit D/A Converter (MC1408-7)	1.49
DAC0808	16	8-Bit D/A Converter (MC1408-8)	2.25
DAC0830	20	8-Bit Up D/A Conv. (.05% Lin.)	5.95
DAC0831	20	8-Bit Up D/A Conv. (.10% Lin.)	4.49
DAC1000	24	10-Bit D/A Conv. Micro. Comp. (0.05%)	7.95
DAC1008	20	10-Bit D/A Conv. Micro. Comp. (0.20%)	6.95
DAC1022	16	10-Bit D/A Conv. (0.20% lin.)	5.95
DAC1222	18	12-Bit D/A Conv. (0.20% Lin.)	6.95
DAC1230	20	12-Bit Up D/A Conv. (.05% Lin.)	14.95
DAC1231	20	12-Bit Up D/A Conv. (.10% Lin.)	13.95
AY-3-1015D	40	25K Baud UART	4.25
AY-5-1013A	40	30K Baud UART (TR1602)	3.95

Low Profile (Tin) Sockets

Part No.	1-9	10-99	100-up
8 pin LP	.16	.14	.13
14 pin LP	.17	.15	.14
16 pin LP	.19	.17	.16
18 pin LP	.26	.24	.23
20 pin LP	.30	.27	.25
22 pin LP	.31	.28	.26
24 pin LP	.33	.30	.28
28 pin LP	.40	.37	.35
40 pin LP	.49	.46	.43

Soldertail (Gold) Standard

Part No.	1-9	10-99	100-up
8 pin SG	.39	.35	.29
14 pin SG	.49	.45	.39
16 pin SG	.55	.49	.45
18 pin SG	.65	.59	.51
20 pin SG	.75	.65	.59
22 pin SG	.79	.69	.65
24 pin SG	.79	.69	.65
28 pin SG	.95	.85	.75
36 pin SG	1.25	1.15	.99
40 pin SG	1.39	1.25	1.15

Wire Wrap Sockets (Gold) Level #3

Part No.	1-9	10-99	100-up
8 pin WW	.55	.49	.45
10 pin WW	.69	.65	.59
14 pin WW	.75	.69	.65
16 pin WW	.79	.72	.65
18 pin WW	.95	.85	.75
20 pin WW	1.19	1.09	.95
22 pin WW	1.29	1.19	1.05
24 pin WW	1.35	1.19	1.09
28 pin WW	1.69	1.55	1.39
36 pin WW	1.89	1.79	1.69
40 pin WW	2.29	1.95	1.79

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Part No.	1-9	10-99	100-up
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16 pin HP	.69	.65	.59
24 pin HP	1.15	.99	.89

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7045EV/Kit	28	Stopwatch Chip, XTL (Evaluation Kit)	19.95
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7106EV/Kit	40	IC, Circuit Board, Display (Evaluation Kit)	46.95
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7107EV/Kit	40	IC, Circuit Board, Display (Evaluation Kit)	46.95
7116CPL	40	3½ Digit A/D LCD Dis. HLD	10.95
7201IUS		Low Battery Volt. Indicator	2.25
7205IPG	24	CMOS LED Stopwatch/Timer	14.95
7205EV/Kit	24	Stopwatch Chip, XTL (Evaluation Kit)	16.95
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7206CEV/Kit	16	Tone Generator Chip, XTL (Evaluation Kit)	7.95
7207AIPD	14	Oscillator Controller	5.95
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7216AIJI	28	8 Digit Univ. Counter C.A.	31.49
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7226AEV/Kit	40	5 Function Counter Chip, XTL (Evaluation Kit)	99.95

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74HC HIGH SPEED CMOS

Part No.	Pins	Price
74HC00	14	.59
74HC02	14	.59
74HC03	14	.89
74HC04	14	.59
74HCU04	14	.69
74HC08	14	.59
74HC10	14	.59
74HC11	14	.69
74HC14	14	.89
74HC20	14	.59
74HC27	14	.59
74HC30	14	.69
74HC32	14	.79
74HC42	16	1.09
74HC51	14	.89
74HC58	14	.89
74HC73	14	.79
74HC74	14	.79
74HC75	16	.99
74HC76	16	.79
74HC85	16	1.69
74HC86	14	.75
74HC107	14	.79
74HC109	16	.79
74HC112	16	.79
74HC123	16	2.29
74HC125	14	1.75
74HC132	14	1.29
74HC137	16	1.59
74HC138	16	1.19

Part No.	Pins	Price
74HC139	16	1.05
74HC147	16	1.29
74HC151	16	.99
74HC153	16	1.09
74HC154	24	2.65
74HC157	16	.99
74HC158	16	.99
74HC160	16	1.39
74HC161	16	1.39
74HC162	16	1.39
74HC163	16	1.39
74HC164	14	1.35
74HC165	16	2.15
74HC166	16	2.49
74HC173	16	1.29
74HC174	16	1.09
74HC175	16	1.09
74HC190	16	1.59
74HC191	16	1.59
74HC192	16	1.49
74HC193	16	1.49
74HC194	16	1.19
74HC195	16	1.19
74HC221	16	2.95
74HC237	16	1.49
74HC240	20	2.29
74HC241	20	2.29
74HC242	14	2.15
74HC243	14	2.15
74HC244	20	2.29

Part No.	Pins	Price
74HC245	20	2.59
74HC251	16	.99
74HC253	16	1.09
74HC257	16	.99
74HC259	16	1.69
74HC266	14	.89
74HC273	20	2.79
74HC280	14	4.59
74HC299	20	5.59
74HC366	16	2.59
74HC367	16	2.59
74HC373	20	2.69
74HC374	20	2.69
74HC390	16	1.59
74HC393	14	1.59
74HC533	20	2.69
74HC534	20	2.69
74HC595	16	3.19
74HC688	20	3.59
74HC4024	14	1.75
74HC4040	16	1.49
74HC4049	16	.89
74HC4050	16	.89
74HC4060	16	1.49
74HC4075	14	.59
74HC4078	14	.59
74HC4511	16	1.95
74HC4514	24	4.19
74HC4538	16	2.59
74HC4543	16	3.75

74HCU04 is unbuffered.

74C—C/MOS

Part No.	Pins	Price
74C00	14	.29
74C02	14	.35
74C04	14	.35
74C08	14	.35
74C10	14	.35
74C14	14	.59
74C20	14	.35
74C30	14	.35
74C32	14	.39
74C42	16	1.19
74C48	16	1.79
74C73	14	.69
74C74	14	.59
74C85	16	1.39
74C86	14	.29
74C89	16	5.95
74C90	14	1.09
74C93	14	1.09
74C95	14	1.19

Part No.	Pins	Price
74C107	14	.79
74C151	16	2.19
74C154	24	3.25
74C157	16	1.75
74C160	16	1.19
74C161	16	1.19
74C162	16	1.19
74C163	16	1.19
74C164	14	1.29
74C165	16	1.29
74C173	16	.89
74C174	16	1.19
74C175	16	1.19
74C192	16	1.39
74C193	16	1.39
74C195	16	1.29
74C221	16	1.75

Part No.	Pins	Price
74C240	20	1.95
74C244	20	1.95
74C373	20	2.29
74C374	20	2.29
74C901	14	.59
74C902	14	.79
74C903	14	.59
74C906	14	.59
74C907	14	.89
74C911	28	8.95
74C912	28	8.95
74C915	18	1.19
74C917	28	8.95
74C922	18	4.49
74C923	20	4.95
74C925	16	5.95
74C926	18	5.95
80C95	16	.69
80C97	16	.69

LINEAR

Part No.	Pins	Price
DS0026CN	8	1.95
TL071CP	8	.79
TL072CP	8	1.09
TL074CN	14	1.95
TL081CP	8	.59
TL082CP	8	1.19
TL084CN	14	1.95
LM109K		5.95
LM301CN	8	.39
LM302H		2.49
LM304H		1.95
LM305H		.99
LM307CN	8	.49
LM308CN	8	.69
LM309K		1.25
LM310CN	8	1.95
LM311CN	8	.59
LM312H		2.79
LM317T		1.19
LM317K		3.49
LM318CN	8	1.59
LM319N	14	1.49
LM320K-5		1.35
LM320K-12		1.35
LM320K-15		1.35
LM320K-24		1.35
LM320T-5		.85
LM320T-12		.85
LM320T-15		.85
LM320T-24		.85
LM322N	14	1.49
LM323K		4.95
LM324N	14	.59
LM329DZ		.65
LM331N	8	3.95
LM334Z		1.19
LM335Z		1.29
LM336Z		1.09
LM337MP		1.15
LM337T		1.89
LM338K		6.95
LM339N	14	.69
LM340K-5		1.35
LM340K-12		1.35
LM340K-15		1.35
LM340K-24		1.35
LM340T-5		.75
LM340T-12		.75
LM340T-15		.75
LM340T-24		.75
LF347N	14	1.49
LM348N	14	.89
LM350K		4.79
LF351N	8	.59
LF353N	8	.89

Part No.	Pins	Price
LF355N	8	1.09
LF356N	8	1.09
LM358N	8	.59
LM359N	14	1.79
LM370N	14	4.95
LM373N	14	4.95
LM377N	14	1.95
LM380CN	8	1.09
LM380N	14	.89
LM381N	14	1.79
LM382N	14	1.49
LM384N	14	1.95
LM386N-3	8	.89
LM387N	8	1.39
LM389N	18	1.19
LM391N-80	16	1.19
LM392N	8	.59
LM393N	8	.45
LF398N	8	3.95
LM399H		5.95
LF412CN	8	1.95
TL494CN	16	2.79
TL496CP	8	1.59
NE531V	8	1.79
NE540H (C540H)		2.95
NE544N	14	1.95
NE550A	14	1.95
NE555V	8	.35
XR-L555	8	.69
LM556N	14	.79
NE558N	16	1.59
NE564N	16	1.95
LM565N	14	.99
LM566CN	8	1.49
LM567V	8	.99
NE570N	16	2.95
NE571N	16	2.49
NE592N	14	1.19
LM703CN	8	1.49
LM710N	14	.69
LM711N	14	.79
LM723N	14	.49
LM733N	14	.89
LM739N	14	1.95
LM741CN	8	.39

Part No.	Pins	Price
LM747N	14	.69
LM748N	8	.59
UA760HC		9.95
LM1456V	8	1.95
LM1458CN	8	.59
LM1488N	14	.69
LM1489N	14	.69
LM1496N	14	.99
LM1605CK		9.95
LM1871N	18	2.95
LM1872N	18	3.25
LM1877N-9	14	2.95
LM1889N	18	1.95
LM1896N	14	1.59
LM2002T		1.95
ULN2003A	16	1.49
XR2206	16	3.95
XR2207	14	2.49
XR2208	16	1.79
XR2211	14	2.95
LM2877P		1.95
LM2878P		2.95
LM2901N	14	.79
LM2902N	14	.89
LM2907N	14	2.49
LM2917N	8	1.95
LM3900N	14	.59
LM3905CN	8	1.19
LM3909N	8	.89
LM3914N	18	2.39
LM3915N	18	2.39
LM3916N	18	2.39
RC4136N	14	1.25
RC4151NB	8	1.95
RC4193NB	8	1.95
RC4195TK		5.95
LM4250CN	8	1.49
NE5532	8	1.69
NE5534	8	1.39
78L05A		.39
78L12A		.39
79L05A		.59
79M05AH		1.29
ICL8038	14	3.95
LM13080N	8	1.19
LM13600N	16	1.19
75477	8	.99
76002	14	1.95
76477	28	3.95

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MPI51S. $89.95

EXPAND TRS-80 MEMORY

TRS-80 MODEL I, III

Each Kit comes complete with eight MM5290 (UPD416/4116) 16K Dynamic RAMs and documentation for conversion. Model 1: 16K equipped with Expansion Interface can be expanded to 48K with 2 Kits. Model III: Can be expanded from 16K to 48K using 2 Kits. Each Kit will expand computer by 16K increments.

TRS-16K3 200ns (Model III). $6.29
TRS-16K4 250ns (Model 1). $5.49

TRS-80 COLOR AND COLOR II

Easy to install Kit comes complete with 8 each 4164N-20 (200ns) 64K Dynamic RAMs and documentation for conversion. Converts TRS-80 Color Computers with D, E, ET, F and NC circuit boards to 32K. Also converts TRS-80 Color Computer II to 64K. Flex DOS or OS-9 required to utilize full 64K RAM on all computers.

TRS-64K-2. . . . . $11.95

Update! TRS-80 MODEL IV, 4P *Update!*

Easy to install Kits come complete with: TRS-64K-2 (8 ea. 4164N-20 (200ns) 64K Dynamic RAMs); TRS-64K-2PAL (8 ea. 4164's plus PAL chip) and documentation for conversion.

TRS-64K-2 Expands Model IV from 16K-64K or Model IV & 4P from 64K-128K (w/Mem. Disk). . . . **$11.95**
TRS-64K-2PAL Expands Model IV (w/Black & White Monitors only) from 64K to 128K **$29.95**

• TRS-80 Model 100 • NEC • Olivetti

Easy to install module plugs right into the socket increasing memory in 8K increments. Complete with module and documentation for installation.

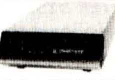
M1008K (TRS-80 Model 100 Expansion). . . . . . **$39.95 ea. or 3 for $99.95**
NEC8KR (NEC PC-8201A & Olivetti M10). . . . . . **$39.95 ea. or 3 for $99.95**

NEW! NEW! TANDY 200 *NEW! NEW!*

NEW! Easy to install module plugs right into the socket increasing memory in 24K increments. Complete with module & documentation for installation.

M200R (Tandy 200 Expansion). . . . . $149.95 ea. or 2 for $274.95

PROMETHEUS MODEMS



Intelligent 300/1200 Baud Modem with Real Time Clock/Calendar

The ProModem™ is a Bell 212A (300/1200) intelligent stand-alone modem • Hayes command set compatible plus an additional extended command set • Shown with alphanumeric display option.

PM1200 RS-232 Stand-Alone Unit. $299.95

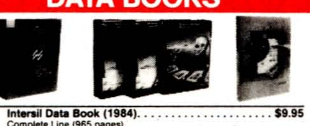
OPTIONS FOR ProModem 1200

PM-COM (ProComm Communication Software). Please specify Operating System. **$79.95**
PM-OP (Options Processor). **$79.95**
PMO-64K (Options Processor Memory – 64K). . . . . **$ 8.49**
PM-ALP (Alphanumeric Display). **$79.95**

PM-Special (Incl. Options Processor, 64K Memory and Alphanumeric Display). **$149.95**

DATA BOOKS





30009 Intersil Data Book (1984). $9.95
Complete Line (965 pages).

30013 Zilog Data Book (1984). $9.95
Microprocessors and Support Chips (849 pages).

210830 Intel Memory Components Hndbk. (1983/84). . . . $14.95
Contains all Applications Notes, Article Reprints, Data Sheets & other design information on Intel's RAMs, DRAMs, EPROMs, E²PROMs and Bubble Memories (880 pages).

230843 Intel Microsystem Components Hndbk. (1983/84) $19.95
Contains Data Sheets on all of Intel's Microprocessors & peripherals – 2 volumes (2575 pages).

30022 National Logic Data Book Set (1984). $24.95
Volumes I & II (3485 pages).
Contains information on National's TTL product line and CD4000 family. This includes 7400, 74L, S, AS, LS and ALS Series devices, and MM54HC / 74HC / 54HCT / 74HCT High Speed Micro CMOS family, MM54C / 74C family, and CMOS LSI / VLSI.



Muffin-Style and Sprite-Style Fans

MUF60 (SPN3-15-2462)
Howard Industries (4.68"sq.,60cfm). . . . **$9.95**
SU2C7 Reverse Flow
EG&G Rotron (3.125" sq., 32cfm). **$9.95**

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APPLE* Compatible CARDS

Key: a = Apple II or II+
b = Apple *IIe*

16K RAM Card (Language Card)

The ARC-16K RAM Card allows the Apple* II and II+ computers to expand from 48K to 64K. Complete with instructions. Key: (a)

ARC-16K. $39.95

Z-80 CP/M Card

The AZ80-1 is Soft-card compatible. Used with CP/M related programs. Software not included. Key: (a,b)

AZ80-1. . . . . $49.95

EPROM Burner Card

The AEB-2 allows user to program and work with standard EPROMs (2716, 2732 & 2764). Easy to use, on-board firmware. Menu contains the following options: Write, Read, Copy, Compare, Blank-Check and Monitor. Complete with instructions. Key: (a,b)

AEB-2. . . . . $69.95

80-Column Card w/Soft Switch

The A80-C is an 80-column card designed for the Apple* II and II+ computers. The card is equipped with a soft switch which allows easy hookup for any monitor. The A80-C also features inverse video capabilities. This card is similar to the Videx*** 80 column card. Complete with instructions. Key: (a)

A80-C. $74.95

Super Serial Card

The ASSC-P is a serial card with a printer mode. It generates standard RS-232C signals and is similar to the Apple* Super Serial Card. Complete with instructions. Key: (a,b)

ASSC-P. $99.95

Parallel Graphics Printer Card w/64K Buffer

The APC-64K is a parallel graphics printer card with a 64K buffer and graphic dump capabilities. Complete with instructions. Key: (a,b)

APC-64K. $129.95

80-Column/64K RAM Card

Extended 80-Column/64K RAM Card expands memory by 64K to give 128K when used with programs like VisiCalc™. Complete with instructions. Key: (b)

JE864. . . . . $79.95

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**VisiCalc is a registered trademark of Visi Corp. Inc. ***Videx is a registered trademark of Videx Inc.

APPLE™ Compatible 5¼" Half-Height Disk Drive



ONLY $129.95

• Uses Chinon Pinch-type mechanics • 143K formatted storage • 35 tracks • Super quiet • Works with Apple Controllers or other compatibles (ACC-1) right • Complete with connector – just plug into your controller • Size: 5¾"W x 1⅝"H x 8"D • Wt.: 4 lbs. Key: (a,b)

ADD-12. . . . . $129.95

APPLE™ Compatible 5¼" Disk Drive & Controller Card

• Uses Shugart SA390 mechanics • 143K formatted storage • Color matches Apple Computer • Works with Apple Controller or other Apple-compatible controllers (ACC-1) • Complete with connector – just plug into your disk controller card • 35 tracks • Size: 6"W x 3½"H x 8-9/16"D • Wt.: 4¼ lbs. Key: (a,b)

ADD-514 (Disk Drive). $149.95
ACC-1 (Controller Card). . . . . $ 49.95

APPLE™ *IIc* Compatible 5¼" Half-Height Disk Drive

• Same specs as ADD-12 (left) except no controller necessary.

ADD-IIc. $129.95

Additional Apple* Compatible Products

APF-1	Cooling Fan with surge protection • Key: (a,b).	$ 39.95
JE614	Numeric/Aux. Keypad–23 accessible functions • Key: (b). . . .	$ 49.95
EAEC-1	Expanded Apple Enclosure Case only • Key: (a).	$ 49.95
KHP4007	Switching Power Supply • Key: (a).	$ 59.95
KB-A68	68-Key Apple Keyboard only • Key: (a).	$ 69.95
MON-12G	12" Green Monitor with swivel stand • Key: (a, b & *IIc*).	$ 79.95
JE520AP	Voice Synthesizer – Plug-in, User Ready • Key: (a,b).	$119.95
KB-EA1	Apple Keyboard and Case • Key: (a).	$119.95
PM1200A	Prometheus Internal Modem – 2 cards • Key: (a,b).	$299.95
PM1200M	Prometheus Macintosh Ext. Modem • Key: (Macintosh).	$369.95

General Application Power Supplies



Power/Mate Corp. REGULATED POWER SUPPLY

• Input: 105-125/210-250VAC @ 47-63Hz • Line regulation: ±0.05% • Three mounting surfaces • Overvoltage protection • UL recognized • CSA certified

Part No.	Output	Size	Weight	Price
EMA5/6B	5V@3A/6V@2.5A	4⅞"Lx4"Wx2⅛"H	2lbs.	$29.95
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KEPCO/TDK 4-OUTPUT SWITCHING POWER SUPPLY

• Ideal for disk drive needs of CRT terminals, microcomputers and video games • Input: 115/230VAC, 50/60Hz • Output: +5V @ 5A, +12V @ 1.8A, +12V @ 2A, −12V @ 0.5A • UL recognized • CSA certified • Size: 7⅜"L x 6-3/16"W x 1⅝"H • Weight: 2 lbs.

MRM 174KF. $39.95

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IBM PC/XT Compatible Keyboard



IBM-5151 (Equivalent to Keytronics™ 5151). **$129.95**

Additional Add-Ons Available!

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IBM PC, PC XT and Compatibles

The IBM64K Kit will increase memory in 64K byte increments. The Kit is simple to install – just insert the 9 - 64K RAM chips in the provided sockets and set the 2 groups of switches. Conversion documentation included.

IBM64K (Nine 200ns 64K RAMs). $9.95

IBM PC AT

Each kit comes complete with nine 128K dynamic RAMs and documentation for conversion.

IBM128K (Nine 250ns 128K RAMs). $79.95



IBM PCXT Equivalent 130 Watt Power Supply

UPGRADE YOUR PC!

• Input: 110V @ 60Hz • Output: +5VDC @ 15A, −5VDC @ 0.5A, +12VDC @ 4.2A, −12VDC @ 0.5A • Plug compatible connectors • Fits into IBM PC • Weight: 6 lbs.

IBM-PS. $119.95

Prometheus Modems

The ProModem 1200B/BS is a 1200/300 baud modem card which plugs into IBM PC and XT. Provides a third serial Comport. Two versions available: 1200B (without software) and 1200BS (with software). The PM1200BS is supplied with powerful MITE communications software from Mycroft labs.

PM1200B (without Software). **$239.95**
PM1200BS (with MITE Software). **$274.95**

IBM Compatible! DISK DRIVES



Documentation Included

RFD480	(Remex 5¼" DS full-ht.).	$ 79.95
FD55B	(Teac 5¼" DS half-ht.).	$119.95
SA455	(Shugart 5¼" DS half-ht.). . . .	$109.95
TM100-2	(Tandon 5¼" DS full-ht.).	$129.95

5¼" DISK DRIVE ENCLOSURES

Complete with power supply, switch, power cord, fuseholder and connectors

DDE-1FH	(Houses 1 full-ht. 5¼" floppy drive) . .	$ 69.95
DDE-2HH	(Houses 2 half-ht. 5¼" floppy drives – vertical).	$ 79.95
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General Application Keyboards

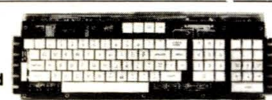
Mitsumi 54-Key Unencoded All-Purpose Keyboard



• SPST keyswitches • 20 pin ribbon cable connection • Low profile keys • Features: cursor controls, control, caps (lock), function, enter and shift keys • Color (keycaps): grey • Weight: 1 lb. • Pinout incl. • Size: 13⅛"L x 4¼"W x ¾"H

KB54. . . . . $14.95

74-Key ASCII Cherry Keyboard



• 7-bit parallel ASCII • Full Upper Case, Full Lower Case except l, m, n, o and p. • Cursor keypad • SPST mechanical keyswitches • 26-pin header connector • Color: white • Size: 18"L x 6¼"W x 1¼"H • Spec included

KB8201. . . . . . *(1700 available)*. $19.95

UV-EPROM ERASER

8 Chips - 21 Minutes

1 Chip - 15 Minutes

Erases all EPROMs. Erases up to 8 chips within 21 minutes (1 chip in 15 minutes). Maintains constant exposure distance of one inch. Special conductive foam liner eliminates static build-up. Built-in safety lock to prevent UV exposure. Compact – only 9.00"L x 3.70"W x 2.60"H. Complete with holding tray for 8 chips.

DE-4 UV-EPROM Eraser. $74.95
UVS-11EL Replacement Bulb. $16.95

Inquiry 197

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CHAPTER XI OSBORNE USERS' GROUP, Charles M. Greene, 18799 Rio Vista Dr., Tequesta, FL 33458. Monthly meetings, newsletter.

FORT MCMURRAY BBS, Peter Steeper, Brick Shirthouse, 226 Gregoire Dr., Fort McMurray, Alberta T9H 4K6, Canada, (403) 791-9388. Public-domain software BBS at (403) 791-9367.

LOGIC, Department B, Box 696, Station B, Willowdale, Ontario M2K 2P9, Canada. For Apple users. SIGs, technical assistance, public-domain software library, monthly magazine, and 300-bps BBS at (416) 445-5192.

PIONEER VALLEY PC USERS GROUP (PVPCUG), Jeff Kane, POB H, North Amherst, MA 01059, (413) 549-4930. Monthly meetings for personal computer users between Springfield, MA, and Brattleboro, VT. Affiliated with the Boston Computer Society.

LATHAM/ALBANY/TROY KAYPRO USERS GROUP (LATKUG), Paul Spannbauer, 16 Maple St., Latham, NY 12110. Monthly meetings and newsletter, public-domain software library.

IN TOUCH, 3632 CTH I, Saukville, WI 53080. Bimonthly newsletter listing user-written software and used hardware. Annual subscription: $2.

TRS-80 COMPUTER SOCIETY OF DIABLO VALLEY, Susan Copeland, POB 23438, Pleasant Hill, CA 94523, (415) 372-7003. Monthly meetings in Concord, CA, BBS, bulletin, and library. Annual dues: $20; three-month trial: $5.

SCIENCENET, Omnet Inc., 70 Tonawanda St., Boston, MA 02124, (617) 265-9230. An electronic mail service for research groups. Subscription to bimonthly newsletter free to potential users.

LOS ANGELES MORROW USERS GROUP, Seymour Saks, 1072 Stearns Dr., Los Angeles, CA 90035, (213) 939-3482. Monthly newsletter and meetings, public-domain software library.

TRULY PORTABLE, POB 1169, Berkeley, CA 94701, (415) 658-1889. Newsletter for NEC PC-8201A, Radio Shack Model 100, Epson Geneva, HP 110, and other portables. Subscription: $16 for 10 issues; $28 overseas; sample issue, $2.50.

MACINTOSH COMPUTER USERS GROUP OF THE SANGAMON VALLEY, Mark Pence, 1540 West Cook St., Springfield, IL 62704, (217) 546-2782. Informal monthly meetings to discuss the Macintosh.

GREATER COLUMBIA AREA XEROX USER GROUP, Ed Bachman, HCFA, 2F3 Meadows East Building, 6300 Security Blvd., Baltimore, MD 21235, (301) 597-3069; Joan McGuire, (301) 594-0128. For users of Xerox 860, 820, 16/8, and Ethernet.

JACKSONVILLE ATARI COMPUTER ENTHUSIASTS (JACE), 1187 Dunbar Court, Orange Park, FL 32073. Monthly meetings and demonstrations, newsletter, disk and cassette software library, 24-hour BBS at (904) 733-4515. Annual dues: $10.

FUTURE GENERATIONS COMPUTER SYSTEMS, Karin van Schouten, North-Holland, P.O. Box 1991, 1000 BZ Amsterdam, The Netherlands. Journal for scientists, managers, and policymakers in the information industry. Subscription: $156.30. For a free copy, write Elsevier Science Publishing Co. Inc., POB 1663, Grand Central Station, New York, NY 10163.

GRAND RAPIDS IBM PC USERS GROUP, Steve Hickel, 6441 28th St. SE, Grand Rapids, MI 49506, (616) 972-2178. Monthly meetings and newsletter, BBS, discounts on disks. Annual fee: $20.

NORTH STAR BBS, Brian Holmes, POB 292, Lynwood, CA 90262. 24-hour, 300/1200-bps BBS in Downey, CA, on CP/M public-domain software, at (213) 861-2313. ■

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The C for Microcomputers

PC-DOS, MS-DOS, CP/M-86, Macintosh, Amiga, Apple II, CP/M-80, Radio Shack, Commodore, XENIX, ROM, and Cross Development systems

MS-DOS, PC-DOS, CP/M-86, XENIX, 8086/80x86 ROM

Manx Aztec C86

"A compiler that has many strengths . . . quite valuable for serious work"

Computer Language review, February 1985

Great Code: Manx Aztec C86 generates fast executing compact code. The benchmark results below are from a study conducted by Manx. The Dhrystone benchmark (CACM 10/84 27:10 p1018) measures performance for a systems software instruction mix. The results are without register variables. With register variables, Manx, Microsoft, and Mark Williams run proportionately faster, Lattice and Computer Innovations show no improvement.

	Execution Time	Code Size	Compile/ Link Time
Dhrystone Benchmark			
Manx Aztec C86 3.3	34 secs	5,760	93 secs
Microsoft C 3.0	34 secs	7,146	119 secs
Optimized C86 2.20J	53 secs	11,009	172 secs
Mark Williams 2.0	56 secs	12,980	113 secs
Lattice 2.14	89 secs	20,404	117 secs

Great Features: Manx Aztec C86 is bundled with a powerful array of well documented productivity tools, library routines and features.

Optimized C compiler	Symbolic Debugger
AS86 Macro Assembler	LN86 Overlay Linker
80186/80286 Support	Librarian
8087/80287 Sensing Lib	Profiler
Extensive UNIX Library	DOS, Screen, & Graphics Lib
Large Memory Model	Intel Object Option
Z (vi) Source Editor -c	CP/M-86 Library -c
ROM Support Package -c	INTEL HEX Utility -c
Library Source Code -c	Mixed memory models -c
MAKE, DIFF, and GREP -c	Source Debugger -c
One year of updates -c	CP/M-86 Library -c

Manx offers two commercial development systems, Aztec C86-c and Aztec C86-d. Items marked -c are special features of the Aztec C86-c system.

Aztec C86-c Commercial System	**$499**
Aztec C86-d Developer's System	**$299**
Aztec C86-p Personal System	**$199**
Aztec C86-a Apprentice System	**$49**

All systems are upgradable by paying the difference in price plus $10.

Third Party Software: There are a number of high quality support packages for Manx Aztec C86 for screen management, graphics, database management, and software development.

C-tree $395	**Greenleaf $185**
PHACT $250	**PC-lint $98**
HALO $250	**Amber Windows $59**
PRE-C $395	**Windows for C $195**
WindScreen $149	**FirsTime $295**
SunScreen $99	**C Util Lib $185**
PANEL $295	**Plink-86 $395**

MACINTOSH, AMIGA, XENIX, CP/M-68K, 68k ROM

Manx Aztec C68k

"Library handling is very flexible . . . documentation is excellent . . . the shell a pleasure to work in . . . blows away the competition for pure compile speed . . . an excellent effort."

Computer Language review, April 1985

Aztec C68k is the most widely used commercial C compiler for the Macintosh. Its quality, performance, and completeness place Manx Aztec C68k in a position beyond comparison. It is available in several upgradable versions.

Optimized C	Creates Clickable Applications
Macro Assembler	Mouse Enhanced SHELL
Overlay Linker	Easy Access to Mac Toolbox
Resource Compiler	UNIX Library Functions
Debuggers	Terminal Emulator (Source)
Librarian	Clear Detailed Documentation
Source Editor	C-Stuff Library
MacRam Disk -c	UniTools (vi,make,diff,grep) -c
Library Source -c	One Year of Updates -c

Items marked -c are available only in the Manx Aztec C86-c system. Other features are in both the Aztec C86-d and Aztec C86-c systems.

Aztec C68k-c Commercial System	**$499**
Aztec C68d-d Developer's System	**$299**
Aztec C68k-p Personal System	**$199**
C-tree database (source)	**$399**
AMIGA, CP/M-68k, 68k UNIX	**call**

Apple II, Commodore, 65xx, 65C02 ROM

Manx Aztec C65

"The AZTEC C system is one of the finest software packages I have seen"

NIBBLE review, July 1984

A vast amount of business, consumer, and educational software is implemented in Manx Aztec C65. The quality and comprehensiveness of this system is competitive with 16 bit C systems. The system includes a full optimized C compiler, 6502 assembler, linkage editor, UNIX library, screen and graphics libraries, shell, and much more. The Apple II version runs under DOS 3.3, and ProDOS, Cross versions are available.

The Aztec C65-c/128 Commodore system runs under the C128 CP/M environment and generates programs for the C64, C128, and CP/M environments. Call for prices and availability of Apprentice, Personal and Developer versions for the Commodore 64 and 128 machines.

Aztec C65-c ProDOS & DOS 3.3	**$399**
Aztec C65-d Apple DOS 3.3	**$199**
Aztec C65-p Apple Personal system	**$99**
Aztec C65-a for learning C	**$49**
Aztec C65-c/128 C64, C128, CP/M	**$399**

Distribution of Manx Aztec C

In the USA, Manx Software Systems is the sole and exclusive distributor of Aztec C. Any telephone or mail order sales other than through Manx are unauthorized.

Manx Cross Development Systems

Cross developed programs are edited, compiled, assembled, and linked on one machine (the HOST) and transferred to another machine (the TARGET) for execution. This method is useful where the target machine is slower or more limited than the HOST, Manx cross compilers are used heavily to develop software for business, consumer, scientific, industrial, research, and educational applications.

HOSTS: VAX UNIX ($3000), PDP-11 UNIX ($2000), MS-DOS ($750), CP/M ($750), MACINTOSH ($750), CP/M-68k ($750), XENIX ($750).

TARGETS: MS-DOS, CP/M-86, Macintosh, CP/M-68k, CP/M-80, TRS-80 3 & 4, Apple II, Commodore C64, 8086/80x86 ROM, 68xxx ROM, 8080/8085/Z80 ROM, 65xx ROM.

The first TARGET is included in the price of the HOST system. Additional TARGETS are $300 to $500 (non VAX) or $1000 (VAX).

Call Manx for information on cross development to the 68000, 65816, Amiga, C128, CP/M-68K, VRTX, and others.

CP/M, Radio Shack, 8080/8085/Z80 ROM

Manx Aztec CII

"I've had a lot of experience with different C compilers, but the Aztec C80 Compiler and Professional Development System is the best I've seen."

80-Micro, December, 1984, John B. Harrell III

Aztec C II-c (CP/M & ROM)	**$349**
Aztec C II-d (CP/M)	**$199**
C-tree database (source)	**$399**
Aztec C80-c (TRS-80 3 & 4)	**$299**
Aztec C80-d (TRS-80 3 & 4)	**$199**

How To Become an Aztec C User

To become an Aztec C user call 1-800-221-0440 or call 1-800-832-9273 (800-TEC WARE). In NJ or outside the USA call 201-530-7997. Orders can also be telexed to 4995812.

Payment can be by check, COD, American Express, VISA, Master Card, or Net 30 to qualified customers.

Orders can also be mailed to Manx Software Systems, Box 55, Shrewsbury, NJ 07701.

How To Get More Information

To get more information on Manx Aztec C and related products, call 1-800-221-0440, or 201-530-7997, or write to Manx Software Systems.

30 Day Guarantee

Any Manx Aztec C development system can be returned within 30 days for a refund if it fails to meet your needs. The only restrictions are that the original purchase must be directly from Manx, shipped within the USA, and the package must be in resalable condition. Returned items must be received by Manx within 30 days. A small restocking fee may be required.

Discounts

There are special discounts available to professors, students, and consultants. A discount is also available on a "trade in" basis for users of competing systems. Call for information.

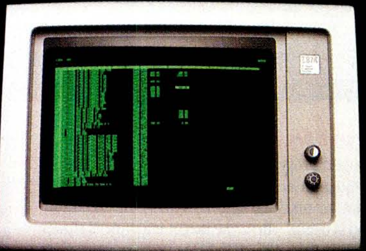
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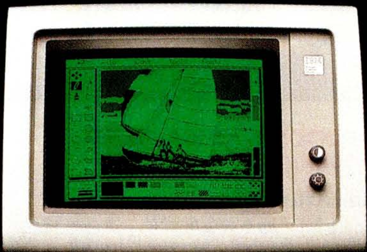


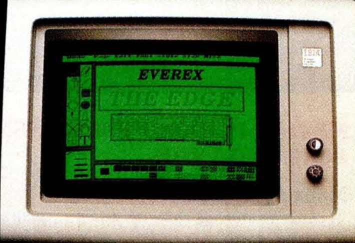
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PC PAINT

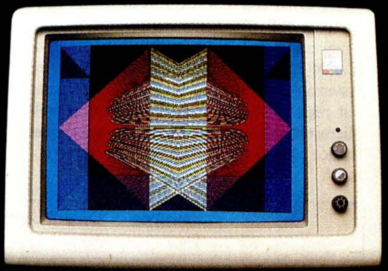


PC PAINTBRUSH 720x348


SYMPHONY HIGH RESOLUTION



PC PAINT


16 COLORS, 320x200

The Edge  The Plain Facts:

EVEREX THE EDGE	Everex The Edge	Paradise Modular Graphics	Tecmar Graphics Master	Tseng Lab Ultra Pak	Persyst Bob	Hercules Graphics Card
• IBM Monochrome Compatible, 720x348, High Resolution	✓		✓	✓		✓
• Runs Lotus 1-2-3™ and Symphony™ in high resolution monochrome:	✓		✓			✓
—132 columnsx25 rows	✓			✓		
—132 columnsx44 rows	✓			✓		
• PC Paintbrush in monochrome	✓		✓	✓		✓
• 16 shades of green on the IBM monochrome monitor	✓	✓				
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—Without software patch needed	✓					
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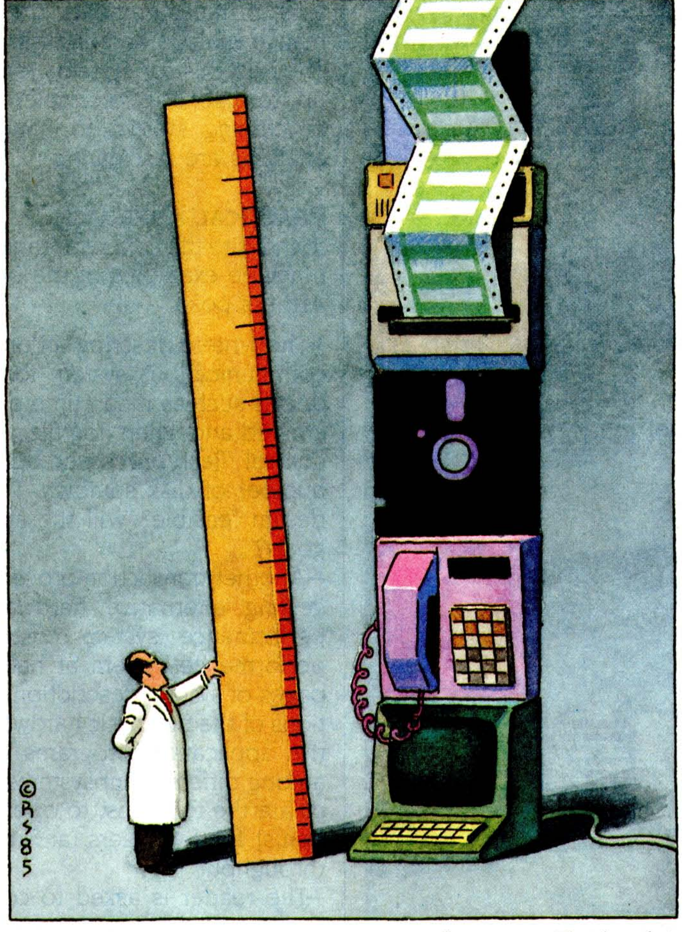
Inquiry 140

A COMPUTER & COMMUNICATIONS NETWORK PERFORMANCE ANALYSIS PRIMER
B. W. Stuck
and E. Arthurs
Prentice-Hall
Englewood Cliffs, NJ: 1985
624 pages, $38.95

APPLIED PROGRAMMING TECHNIQUES IN C
Terry A. Ward
Scott, Foresman and Co.
Glenview, IL: 1985
268 pages, $19.95

DIAGRAMMING TECHNIQUES FOR ANALYSTS AND PROGRAMMERS
James Martin
and Carma McClure
Prentice-Hall
Englewood Cliffs, NJ: 1985
416 pages, $40

INTRODUCTION TO COMPUTER ENGINEERING
Franco P. Preparata
Harper & Row
New York: 1985
336 pages, $37.95



A COMPUTER & COMMUNICATIONS NETWORK PERFORMANCE ANALYSIS PRIMER
Reviewed by Mark Klein

Many of us have struggled with performance problems in computer systems. When CP/M version 2 arrived, we worked to find the optimal sector size to use when formatting disks. Today we worry about effective throughput in local-area networks (LANs) as a function of variables such as transmission speed, message size, or network topology. In making these design decisions, many of us have often relied on an intuition developed by experience.

Of course, performance-analysis problems are not limited to the microcomputer world. I met a BYTE reader who built from scratch a 68000 system as relaxation from his daytime job on a huge SNA (IBM's Systems Network Architecture) network; another computes for fun on an Apple II at home but his vocation is designing on-line transaction-processing systems for a worldwide airline. One of my jobs as system administrator for the two UNIX-based computers that host the BYTE Information Exchange (BIX) was to help find the right mix of port assignments (hard-wired, local network, public-switched network, leased lines, Tymnet) to optimize access and response and minimize cost.

A book that will appeal to many BYTE readers is *A Computer & Communications Network Performance Analysis Primer* by B. W. Stuck and E. Arthurs, both computer scientists at Bell Laboratories. It is a guide to attacking performance-analysis problems in these and other types of systems. The book is not easy reading. It was written from material used to teach a graduate-level computer science course within Bell Labs. The authors assume that you have basic math skills such as linear programming and calculus, that you understand what operating systems are supposed to do, and that you don't blink at terms such as Poisson statistics, packet switching, link-level flow control, blocking, and queueing networks.

But it would be a mistake for a reader to think that this important material is inaccessible just because the book is full of equations and strange terms. A manager without a technical background shouldn't expect to find out from this book whether the planned order-entry system for a company needs a microcomputer or a superminicomputer. Someone else working for that company, however,

(continued)

ILLUSTRATED BY ROB SAUNDERS

could use the book to assess the resource needs and offer detailed quantitative support for a decision to buy, say, a VAX-11/780 instead of an 11/750.

Stuck and Arthurs take an engineer's approach. The book is, as the title claims, a primer. The authors teach by example and case study. They describe a computer communications system using flow diagrams and system data (and they don't split hairs on what is computer and what is communications). They quantify performance with a list of measurements, present the results of a performance analysis, and discuss the significance of the results. They do this for systems ranging from secretaries lining up to use a photocopier to an on-line transaction-processing system to handle telephone repairs. The analyses are fascinating.

PRACTICAL APPROACH

To indicate the concrete, engineer's approach of this book, I include examples of the types of problems Stuck and Arthurs pose.

—The writers describe an on-line point-of-sale computer communications system for a widget retailer, down to details such as mean time per disk access, what files are created and when (log files, credit-check files, inventory-control files), processor busy time per transaction, and number of disk spindles. The question follows: "Is this design feasible? Will the system meet its performance goals?"

—Another transaction-processing problem begins by suggesting alternative hardware configurations: a high-performance system costing $200,000 and a low-performance system at half that cost. After two more pages of system description, including possible combinations of the two basic hardware configurations that divide the application programs and operating-system code among different subsystems, the reader is asked to "calculate the total cost to operate each [of four] configuration[s] for five years, and the ratio of cost divided by throughput."

—The reader is asked to compare performance of two systems. In the first system, one secretary is assigned to 10 professionals and handles all document-preparation needs. In the second system, a text-processing center is set up.

—Another problem deals with insurance agents who dial up through a voice telephone network to a central computer and then use a terminal connected to a modem to query about different types of policies for potential customers. After considerable details, the reader is asked to figure out "how many modems are needed if the fraction of queries blocked due to no modem being available is no more than one query in ten."

Stuck and Arthurs subject packet-switching systems and local-area networks to this kind of nitty-gritty analysis throughout the book. Several aspects of these systems are

(continued)



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MWC86 is the easiest to use of all compilers. One command runs all phases from pre-processor to assembler and linker. MWC86 eliminates the need to search for error messages in the back of a manual. All error messages appear on the screen in English.

A recent review of MWC86 in *PC World*, June, 1984, summed it up:

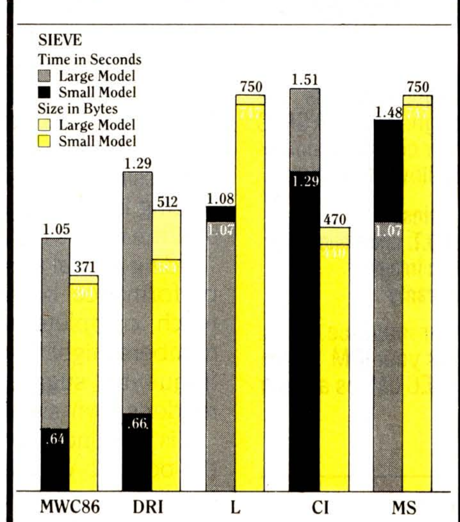
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studied. The last chapter is devoted to an in-depth, use-all-the-tools analysis of LANs.

Office Communications

One particularly relevant and readable chapter covers office communications. The premise to this section is that "the fundamental idea in office automation is to move ideas or information to people and not vice versa." For openers, there is a quantitative analysis of telephone tag; the frightening conclusion is that when "the mean number of tags increases to three, then the maximum mean throughput rate (completed calls) drops to one call lasting ten minutes every 203.5 minutes!" For comparison, the authors cover a voice-storage system.

Other topics in this chapter include copying and reproduction, document preparation, LANs, workstation productivity gains, and the interaction between secretaries and managers. Discussion of a sophisticated model of an automated office system is accompanied by relevant graphs of document-completion rate versus number of secretaries, questions pertaining to how many secretaries can be active inside a document-preparation system before congestion becomes unacceptable, and an analysis of the minimum set of numbers needed to say anything pertinent about these kinds of systems.

Bottleneck Design

Office communications is just one of many systems to which the authors apply their ideas about bottlenecks. Early on, the reader is cautioned to remember that there will always be (by definition) some bottleneck; however, "the design problem is to choose where the bottleneck should be." For example, in their analysis of potential productivity gains that might be achieved in an automated office by giving workstations to professionals, Stuck and Arthurs quantitatively examine the effect of voice and electronic mail on three alternative bottlenecks: meetings, telephone calls, and documentation (filing, gaining access to reports, etc.).

Later they study a proposal to add an LAN to an office system currently running from a central processor. Potential bottlenecks are the clerks (who might not generate enough load to keep the system busy), terminals, central processing unit, disk system, printer, or terminal controller. Putting in the numbers for this particular example shows that the disk is the bottleneck. The authors conclude that "adding a local area network will not significantly improve performance, because the terminal controller [does not] reach complete utilization first." Of course, different numbers might lead to a different conclusion; the authors frequently suggest plugging in the numbers for the reader's own situation.

It is this kind of practical, quantitative analysis that makes the book so valuable. Many computer systems, large and small, are configured according to what feels right to the system designer. Stuck and Arthurs give us some sub-

(continued)

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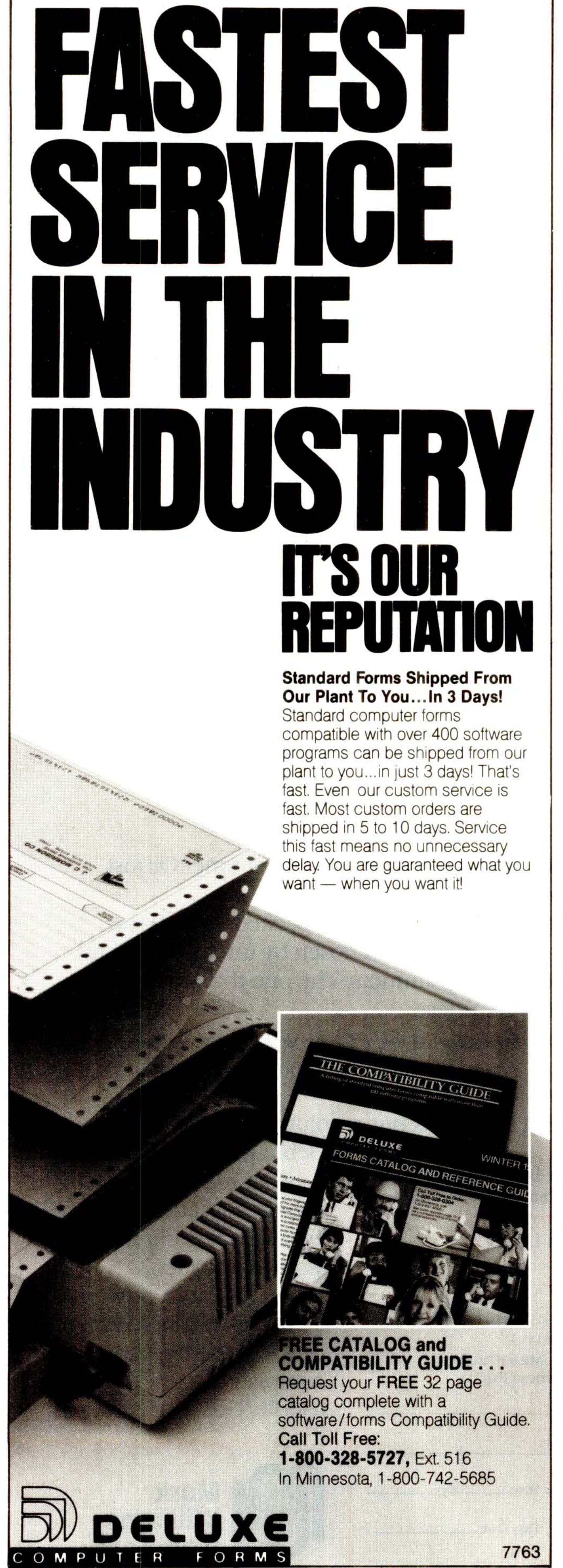
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Inquiry 231



stance on which to base systems decisions. Even more, for someone willing to read the text and work the problems, they offer a path to developing the intuition that is such a crucial part of system design.

Mark Klein (8 Bay Rd., Newmarket, NH 03857) has been involved with the BYTE Information Exchange (BIX) since its inception. He is BYTE's contributing editor on communications. His consulting firm, Channel Computing, specializes in communications technology.

APPLIED PROGRAMMING TECHNIQUES IN C
Reviewed by Phil Hughes

Terry A. Ward's new book on the C language, *Applied Programming Techniques in C*, provides examples of real, useful programs written in C. It does not try to teach you the C language. The people who might be interested in this type of text are those with a basic knowledge of C who want to see some extensive programs written in that language. Another group is composed of owners of CP/M or MS-DOS systems who want to add some UNIX-like utility programs at little cost.

The first chapter presents basic information on operating systems and covers selection of a programming language. Ward limits his discussion of operating systems to Apple DOS, MS-DOS, and CP/M. I was disappointed to see UNIX ignored at this point in the book. The conclusion is as expected—use C—but Ward goes through the paces discussing APL, FORTRAN, Pascal, PL/I, and, of course, BASIC. I take exception to several comments about FORTRAN and Pascal. In particular, Ward claims that few new applications are being written in FORTRAN. This may be the case in the microcomputer world but is certainly not the case in advanced engineering work.

In the next chapter Ward presents a very condensed description of C. This description and the remainder of the book talk about BD Software's version of C (BDS C). This section is poorly written and has quite a few errors. For example, the first program will not compile because there are two statements in the wrong order. The fifth line consisting of a left brace should be moved up before line 3 to correct this error. Another example is on page 23. There is no such operator as the Unary Plus. Also, the descriptions of increment and decrement operators are misleading. When referring to pointers, these operators modify the value of the pointer by the size of the datum pointed to.

Even for the experienced C programmer, these errors detract from the value of the book; it remains difficult to separate errors from dialect differences between C and BDS C.

Programming Tools

In the remaining chapters, the author presents various programming tools. He explains each program and docu-

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BOOK REVIEWS

ments the functions within programs. The first programs are simple utilities such as ones that handle word counting and file comparison.

When I started reading the section on text compression, I thought we were going to get into a meaty program. As Ward suggests, if you want a real text-compression program, you should get it from a CP/M users group. He then goes on with a set of programs to replace spaces with tabs and vice versa.

More than 100 pages are dedicated to a text editor, written by Ed Ream, called ed2. I have used a derivative of this editor and found it to be fast and reliable. But to avoid typing more than 50 pages of source code, you can either purchase it for almost nothing from the C Users' Group (POB 97, McPherson, KS 67460, (316) 241-1065) or buy the fancy, updated version called RED (for a reasonable price of $95) directly from Edward K. Ream at 1850 Summit Ave., Madison, WI 53705, (608) 231-2952.

Other areas Ward covers include text formatting, telecommunications, sorting, and the Othello game. My biggest negative comment on the listings is that each program is written in the style of the author of the program. For example, some listings use the brace matching conventions of Kernighan and Ritchie, while others use the matching indentation styles more common in newer C books. Ward could have used these differences to his advantage by discussing the issue of style, but instead he ignored them. I expect this inconsistency will confuse the beginner.

The appendixes are extensive and provide sources for books, periodicals, C compilers, and public-domain software. There is even a cross-reference for articles written about C.

Ward offers notes on converting programs to and from BDS C. Unfortunately, some of them are wrong. For example, he claims that BDS C supports multiline comments and standard C does not support multiline comments. I suspect he confused this with nested comments. I can assure you that at least the C compilers that have a traceable parentage to Bell Laboratories support multiline comments.

Applied Programming Techniques in C is a disappointment. The appendixes that show sources of software and articles are the best part. It looks like Ward did a lot of research but then ran into a deadline and couldn't get the rest of the book together. For the newcomer to C who wants to look at some code, Ward presents a lot of it. There *are* things to be learned from the book. For the person who wants to get some tools up and running on a CP/M or MS-DOS system, I suggest they purchase the software from the sources of public-domain programs listed in the appendixes.

Phil Hughes (c/o Specialized Systems Consultants, POB 55549, Seattle, WA 98155) is a computer scientist who has worked with UNIX and C for more than five years.

(continued)

BOOK REVIEWS

personal experience. I think, however, that much of the text is too technical for the majority of end users or for any DP managers who have not been involved in systems analysis or programming. It has been my experience that the latter is common because many managers who have become involved in DP operations do not have formal DP backgrounds. Also, there are probably many people in the business (like me) who became involved in systems analysis and programming without a history of flowcharting and DP courses. For me, the text required careful attention to follow the tutorials relating to each technique.

Does It Help?

I approached *Diagramming Techniques* with this question: Can it assist an individual or group with a design background to actually use one of the methodologies? This approach led me to try the action-diagramming method (one the authors highly recommend) for a complex project involving the design of a computer-managed instructional system for a large training project. Before selecting a method, I thoroughly analyzed the type of system we were developing. We needed a method that could lead to computer-generated code, one that could depict a highly complex system, and perhaps most of all, a technique that could communicate this system to managers and end users with little or no programming or computer experience. We also needed a methodology that could be quickly understood by other programmers.

The authors point out that some diagramming techniques are good for presenting the "overview" of program structure, while others are good for describing the "detailed" program logic. The low level (details) should be a natural extension of the high level (overview); action diagrams achieve this. My team found that the instructions in the text were sufficiently clear to adopt this methodology. Action diagrams were quick and easy to draw. It helped greatly that they could be linked to a database. Although our experience with action diagrams has been brief, we are satisfied with both the technique and the instruction provided by Martin and McClure.

The topics addressed in *Diagramming Techniques* are complex. A quick read-through is not sufficient to get any benefit. The book is not intended as a general introduction to the field, despite the lengthy introductory chapters that cover a rationale for selecting a standard method of diagramming. Because of the depth of detail, this text is also not very good for presenting an overview of each of the techniques discussed. What this book is most useful for is presenting a complex analysis of the methods commonly used in the field and helping the serious systems analyst or programmer prepare for the CASA/CAP revolution.

Bonnie L. Walker (4101 Woodhaven Lane, Bowie, MD 20715) is a systems analyst/programmer and a consultant in telecommunications and computer-based training.

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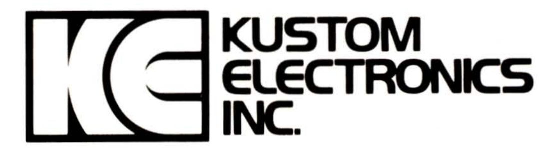
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INTRODUCTION TO COMPUTER ENGINEERING
Reviewed by Brian Edgington

In the preface to *Introduction to Computer Engineering*, Franco P. Preparata describes his book as a "first course text." The book is much more involved than that. Practicing engineers and advanced students could find it helpful for study and review. Used by a competent instructor, it could serve as a good introduction, even though at times its speed and intensity are overpowering.

Each of the book's three parts has distinctly different goals. The first is an overview of information processing, taking the reader from the representation of information through several number bases and base conversions. This presentation requires more mathematical background than most first-year students would normally possess.

Early in the text Preparata introduces binary-coded decimal (BCD) codes, the Gray code, and parity-check codes. Though he mentions error-correction schemes at this point, he never elaborates upon them. The rest of the first part introduces a computer model called the Simplistic Educational Computer (SEC). A description of this machine's logical and functional organization is followed by its basic instruction set and examples of how a microprocessor is programmed for problem solving in assembly or mnemonic-type language. Some readers might consider this approach to be a rather rapid immersion into the complex realm of computer science; without adequate mathematical background or experience with computers, it might well be.

The author provides well-designed problems to explore the concepts he discusses and to encourage thinking about logical solutions using the machine language of the SEC.

Boolean Algebra

The second part of the book is dedicated to one of the subsets of Boolean algebra, switching algebra, and its application to hardware and circuit design. This section is well presented and requires little or no knowledge of algebra. Preparata begins by defining the two values in Boolean math, 1 and 0, and logically develops the principles and rules used to define logic equations. These equations are used to develop combinational networks, groups of gates and switches that make up the basis of computer systems. All the truth tables in this chapter are presented in both standard conventions, allowing the reader to see the same rules in two different lights.

Next Preparata covers analysis and design of combinational networks. If the material he has presented previously has not been understood, the rest may be incomprehensible. Although the text is developed well and takes a logical approach to teaching a complicated subject, it is not for the lightweight.

Again in this section the author seems to have forgotten that his purpose was to write an introductory text. The

(continued)

science of designing combinational and sequential networks is difficult to cover in 200 pages. The information is presented tersely and, if the reader lacks substantial background in networks, can be hard to comprehend.

The next part concerns itself with minimization techniques, the reduction of Boolean equations to their simplest of forms, and Karnaugh mapping and a tabular technique (Quine-McCluskey). These are principles needed in circuit design, but they require more than a chapter to be fully understood and used efficiently. Although the information is not very simple, it is accurate.

The balance of this section develops the basic building blocks of networks and designing with modules. Preparata discusses sequential networks, constructions that require action in preceding sections to cause a predefined chain of events to take place. These are the real techniques necessary in the decision-making circuits that make up present-day computers. Preparata does a very good job of covering this subject matter.

System Plan

The third and last part of the book describes how to put together all of the information and circuit types that have been described previously. Here is where the reader builds his own SEC and learns how to write programs for it. I like the idea of using a model for learning because it allows me to grasp the concept of microprocessors or computers without the bias or commercial influence of using existing products. However, the problem with this teaching method is the same as writing a trilogy: All the parts have to be consistent and well developed or they lose credibility. The author has succeeded. In fact, this section is where the book excels as an introduction to computer engineering. Although Preparata here has a tendency to overwhelm the reader with mathematics at first, he soon settles into a comfortable description and analysis of a processing system. The programming language is expanded, and the processor (SEC) is developed to the point of actual implementation, with the registers and memory map being explained and documented as well as most real products.

This part contains one of the most straightforward and simple explanations of adders and look-ahead systems that I have come across. The author explains how an arithmetic-logic unit is designed and how it functions. He then develops the CPU and demonstrates its use of register transfers and memory.

The SEC's architecture is a good example of current processor technology. It can serve as a good basis for learning and using the microprocessors available on the market today as well as those we will see in the future.

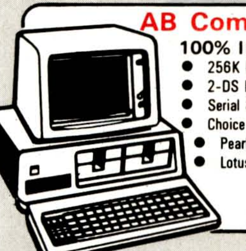
Introduction to Computer Engineering is well written and well documented, but it is not suited for an introductory course. It would serve better at a second-year level or as a review for people already working in the engineering field. ■

Brian Edginton (551 Ramona Ave., Salt Lake City, UT 84105) is a consultant specializing in multiuser business systems.

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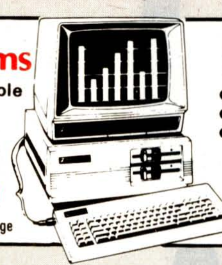


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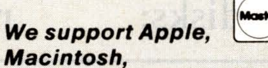
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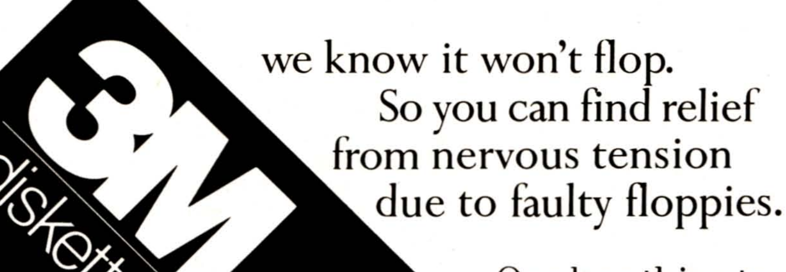
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DATA COMMUNICATIONS WORKSHOPS, various sites throughout the U.S. and Canada. Intel Corp., Westford Corporate Center, Three Carlisle Rd., Westford, MA 01880, (617) 256-1374. *September–December*

C LANGUAGE SEMINAR AND WORKSHOP, Sheraton-Commander Hotel, Cambridge, MA. The fee is $695. Beatrice Blatteis, CL Publications, 131 Townsend St., San Francisco, CA 94107, (415) 957-9353. *September 16–18*

THE FOURTH ANNUAL DATA-STORAGE INTERNATIONAL FORUM, Red Lion Inn, San Jose, CA. Cartlidge & Associates Inc., Suite M259, 1101 South Winchester Blvd., San Jose, CA 95128, (408) 554-6644. *September 16–18*

THE SIXTEENTH CONVENTION INFORMATIQUE, Palais des Congres, Paris, France. Convention Informatique, 4 Place de Valois, 75001, Paris, France; tel: (1) 261 52 42; Telex: 212 597 F. *September 16–20*

THE SIXTH ANNUAL SOFTWARE/EXPO, Infomart, Dallas, TX. Professional Exposition Management Co. Inc., Suite 205, 2400 East Devon Ave., Des Plaines, IL 60018, (800) 323-5155; in Illinois, (312) 299-3131. *September 17–19*

UNIX EXPO: THE UNIX OPERATING SYSTEM EXPOSITION AND CONFERENCE, New York Hilton and Sheraton Centre Hotels, New York City. Robert P. Birkfeld, National Expositions Co. Inc., 14 West 40th St., New York, NY 10018, (212) 391-9111. *September 18–20*

EASTERN COMPUTER MANUFACTURING EXPO, Charlotte, NC. Great Southern Shows, POB 655, Jacksonville, FL 32201, (904) 743-8000. *September 19–21*

THE SEVENTH ANNUAL FORTH CONVENTION AND BANQUET, Hyatt Rickeys, Palo Alto, CA. FORTH Interest Group, POB 8231, San Jose, CA 95155, (408) 277-0668. *September 20–21*

THE TIDEWATER TENTH ANNUAL COMPUTER FAIR, Radio Amateur Hamfest—Electronic Flea Market, Virginia Beach Pavilion, VA. Advance tickets are $5 for both days or $6 at the door. Jim Harrison, Tidewater Radio Conventions Inc., 1234 Little Bay Ave., Norfolk, VA 23503, (804) 587-1695. *September 21–22*

SPACE TECH '85 CONFERENCE AND EXPOSITION, Disneyland Hotel, Anaheim, CA. Society of Manufacturing Engineers, One SME Dr., POB 930, Dearborn, MI 48121, (313) 271-1500. *September 23–25*

THE EIGHTH NORTHEAST COMPUTER FAIRE, Bayside Exposition Center, Boston, MA. Computer Faire Inc., 181 Wells Ave, Newton, MA 02159, (617) 965-8350. *September 26–29*

October 1985

UNIX SYSTEMS EXPO/85-FALL, Bayside Exposition Center, Boston, MA. Computer Faire Inc., 181 Wells Ave., Newton, MA 02159, (617) 965-8350. *October 3–5*

THE FIFTH ANNUAL SYMPOSIUM ON SMALL COMPUTERS IN THE ARTS, Hilton of Philadelphia, Philadelphia, PA. Small Computers in the Arts Network, Symposium, POB 1954, Philadelphia, PA 19105. *October 5–8*

THE SIXTH ANNUAL MEETING OF THE AMERICAN SOCIETY FOR ENGINEERING MANAGEMENT, Portland, OR. American Society for Engineering Management, 301 Harris Hall, University of Missouri-Rolla, Rolla, MO 65401-0249, (314) 341-4560. *October 6–8*

THE FIFTH ANNUAL EDUCATIONAL COMPUTER FAIR, Cleveland, OH. Educational Computer Consortium of Ohio, Teacher Center 271, 1123 S.O.M. Center Rd., Cleveland, OH 44124, (216) 461-0800. *October 11–12*

THE 1985 ASSOCIATION FOR COMPUTING MACHINERY ANNUAL CONFERENCE, Denver Hilton Hotel, Denver, CO. ACM, 11 West 42nd St., New York, NY 10036, (212) 869-7440. *October 14–16*

COMPUTERS AND THE DISABLED CONFERENCE, California State University, Northridge. Dr. Harry J. Murphy, Conference Coordinator, Office of Disabled Student Services, 18111 Nordhoff St., Northridge, CA 91330, (818) 885-2578. *October 17–19*

COMPUTERS IN EDUCATION, Sheraton Centre Hotel, New York, NY. Carole Dornblaser, Conference Management Corp., 17 Washington St., Norwalk, CT 06854, (203) 852-0500. *October 18–20*

NORTHCON/85 AND MINI-MICRO NORTHWEST-85, Memorial Coliseum, Portland, OR. Electronic Conventions Management, 8110 Airport Blvd., Los Angeles, CA 90045, (213) 772-2965. *October 22–24*

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THE SIXTH ANNUAL FEDERAL OFFICE AUTOMATION CONFERENCE, Convention Center, Washington, DC. Federal Office Automation Conference, POB N, Wayland, MA 01778, (617) 358-5356. *October 29–31*

COMPUTER TECHNOLOGY FOR THE HANDICAPPED, Radisson South Hotel, Minneapolis, MN. Closing the Gap, POB 68, Henderson, MN 56044, (612) 248-3294; in Minneapolis/St. Paul, 341-8299. *October 30–November 2* ■

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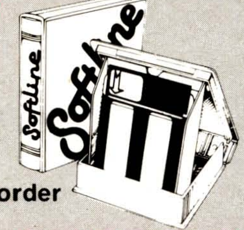
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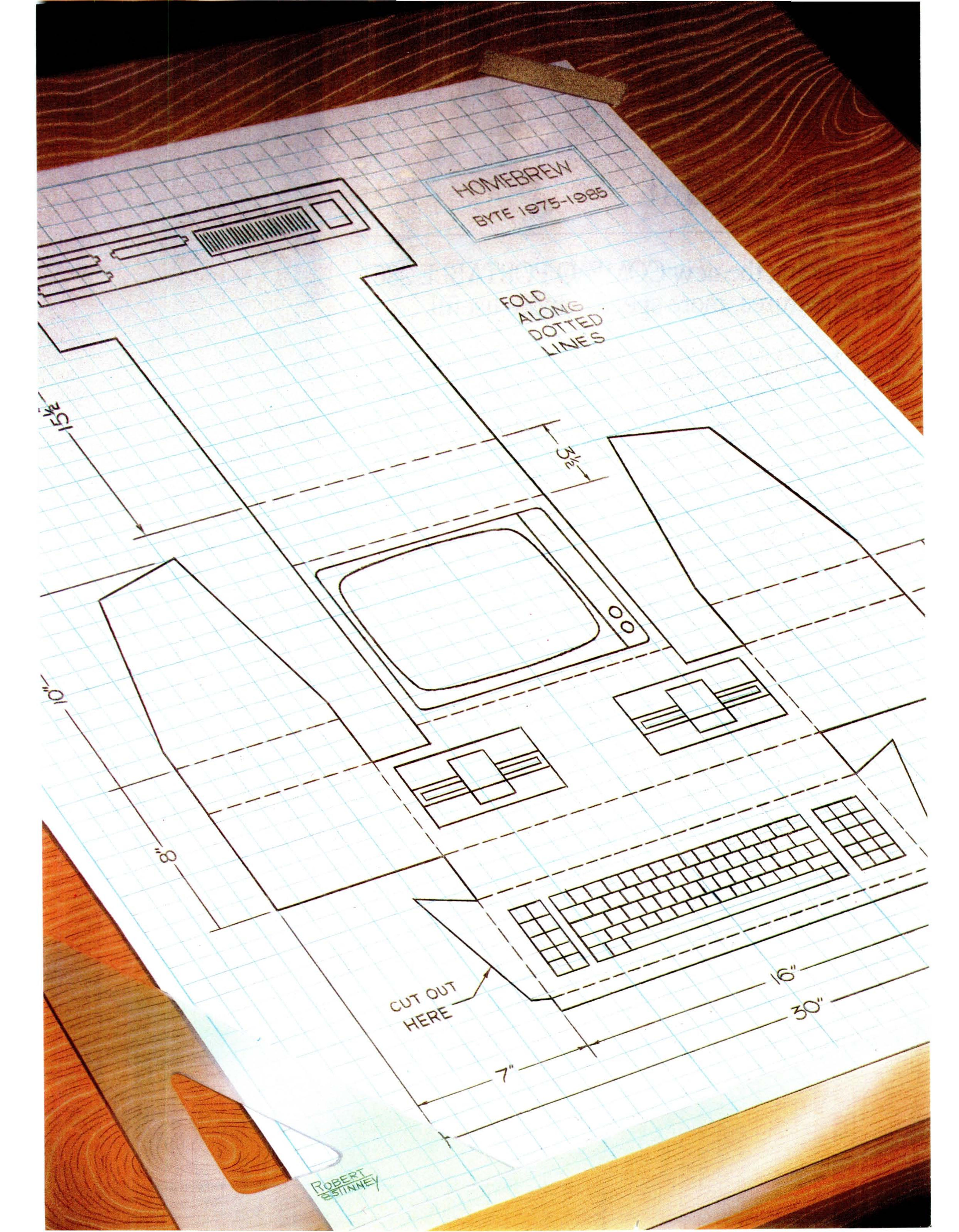
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Features

THE CIRCUIT CELLAR project this month is the innovative SB180 single-board computer. Steve says that the SB180 reasserts 8-bit computing in a 16-bit world. This first part of a two-part article describes the HD64180 chip used, gives an overview of the evolution of CP/M, and describes the design of the computer.

In this month's Programming Project, Jonathan Amsterdam discusses sorting in the context of three different algorithms: Selection Sort, for small lists, Quicksort, for larger lists, and Mergesort, for lists so large they can't fit into memory all at once.

This month we have part 2 of a two-part series describing Definicon Systems Inc.'s DSI-32 32032 coprocessor board for the IBM PC. This part focuses on the software available for the board.

"An Algorithm for Disk Caching with Limited Memory" by Brian McKeon presents a set of C functions that use a small amount of memory to store copies of disk sectors and improve floppy-disk performance. This algorithm is especially helpful when memory space is at a minimum.

Harvard astronomy professor A. G. W. Cameron describes his experiences with number crunching on a progression of computers—beginning in the mid-1950s, when he was working with an IBM 602A, to the present, with PC XT clones—in "Astrophysical Number Crunching."

"Two Generalized Floating-Point Representations" by David Salomon offers two designs, partitioned and variable-based, for support devices that handle floating-point numbers in formats other than the traditional *S E F*.

In "Turbo Pascal Drives the Mouse," John Figueras details a procedure that accesses MS-DOS functions and interrupts and interfaces the Microsoft Mouse with Pascal.

Herbert Stein made some changes to his APC III and ended up with what he considers the fastest low-cost IBM PC clone currently available. His operating-system patch and other upgrades are described in "IBM Compatibility for the NEC APC III."

This month we have another follow-up to last November's "Travesty Generator for Micros" by Hugh Kenner and Joseph O'Rourke. In "Build a Travesty Tree," Peter Wayner explains that tree data structures handle large problems much faster than the method described in the original article.

"Printing Pascal Graphics" by Kelly W. Davis presents a screen-dump program that simplifies graphics creation in Apple Pascal with any MX-series printer from Epson.

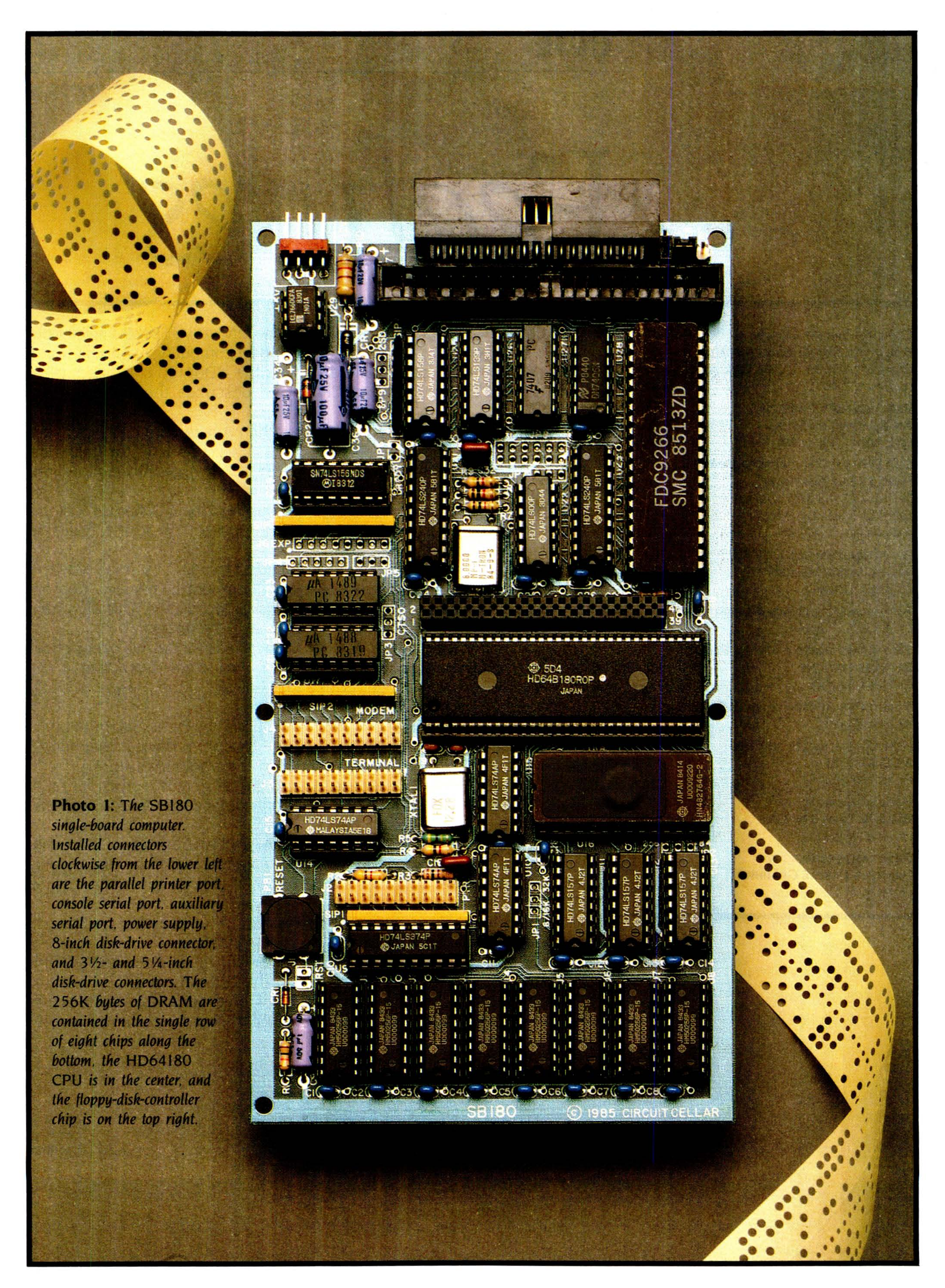


Photo 1: *The SB180 single-board computer. Installed connectors clockwise from the lower left are the parallel printer port, console serial port, auxiliary serial port, power supply, 8-inch disk-drive connector, and 3½- and 5¼-inch disk-drive connectors. The 256K bytes of DRAM are contained in the single row of eight chips along the bottom, the HD64180 CPU is in the center, and the floppy-disk-controller chip is on the top right.*

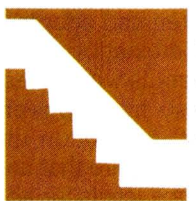
PHOTOGRAPHED BY PAUL AVIS.

BUILD THE SB180 SINGLE-BOARD COMPUTER

PART 1: THE HARDWARE

BY STEVE CIARCIA

This computer reasserts 8-bit computing in a 16-bit world



Newer, faster, better. These words are screamed at you in ads and reviews of virtually every new computer that comes to market. Unfortunately, many of the proponents of this rhetoric are going on hearsay evidence. While advertising hype has its place in our culture, a more thorough investigation may lead you to alternative conclusions.

Generally speaking, quotes of increased performance are basically comparisons of CPU (central processing unit) instruction times rarely involving the operating system. The 68000 is indeed a more capable processor than the 6502, but that doesn't necessarily mean that commercial application programs always run faster because the CPU has more capability. People owning 128K-byte Macintoshes have discovered this.

The bus size of the processor is only one factor in the performance of a computer system. Operating-system design and programming styles contribute much more to the overall throughput of a computer. It is not enough to simply compare 8 to 16 bits or 16 to 32 bits. For example, the Sieve of Eratosthenes prime-number benchmark runs faster in BASIC on the 8-bit 8052-based controller board presented in last month's Circuit Cellar than it does on a 16-bit IBM PC.

The ultimate performance of a computer is the sum of its subsystem interaction times and not just the CPU execution speed. Using a simple database-management program involves interaction among the user input device, operating system, disk drives, firmware, system memory, and user output devices. Slow communication or a bottleneck between any two of these subsystems can degrade the performance of the entire computer.

In my opinion, the processor/operating system connection contributes most to user satisfaction. In the days before the IBM PC, the de facto computer standard was the 8080/Z80 and CP/M 2.2. Unfortunately, software developers considered it difficult to use, especially in turnkey applications. The frustration of having to warm-boot the system merely to change disks and the lack of a PATH command created many ready-and-willing PC-DOS customers. If only there were an 8-bit operating system with the capabilities and friendliness of MS-DOS.

(continued)

Steve Ciarcia (pronounced "see-ARE-see-ah") is an electronics engineer and computer consultant with experience in process control, digital design, nuclear instrumentation, and product development. He is the author of several books about electronics. You can write to him at POB 582, *Glastonbury*, CT 06033.

The Z80 is still considered a high-performance CPU. In reality, the 8-bit processor is a cost-effective and efficient choice for personal computers and industrial controllers. (Remember that peripheral support chips such as PIAs [peripheral interface adapters] and floppy-disk controllers are 8-bit devices, as are many memory chips.) One problem is that the Z80 has an address limitation of 64K bytes, which discourages the use of 50K-byte BASIC interpreters and 100K-byte integrated spreadsheet programs common to IBM PC users. While additional memory has been added through hardware bank switching, it has never been properly integrated into the CP/M operating system, and its function is kludgy. If only someone would design a Z80 chip that directly addresses more than 64K bytes.

THE CIRCUIT CELLAR SB180

Hitachi has recently developed a CMOS (complementary metal-oxide semiconductor) Z80-code-compatible processor, designated the HD64180, that directly addresses 512K bytes. Echelon Systems has developed an operating system for the processor that is an amalgam of CP/M, MS-DOS, and UNIX. This operating system is called the Z-System. Using the HD64180 and the Z-System, I have produced a computer that reasserts 8-bit computing in a 16-bit world and outperforms a standard IBM PC by 20 to 100 percent.

In this two-part article, I take a look at the Hitachi HD64180 and the evolution of CP/M as embodied in the Z-System. The hardware project is a single-board computer (4 by 7½ inches) called the SB180, which is the 29-chip equivalent of a large S-100 system (see photos 1 and 2). Refer to figure 1 for a block diagram of the SB180 board.

The Circuit Cellar SB180 has the following capabilities:

- 256K-byte on-board RAM (random-access read/write memory), which can be partitioned as 64K-byte system memory and 192K-byte RAM disk or as paged system memory
- 32K-byte EPROM (erasable programmable read-only memory)
- full ROM-based monitor with system-disk boot
- two RS-232C serial ports, one with automatic data-transmission-rate detection
- a Centronics parallel printer port
- single/double-density programmable floppy-disk controller capable of handling a mix of up to four 3½-, 5¼-, or 8-inch drives; different-size drives can run concurrently
- requires only +5 volts (V) and +12 V for operation (+12 V only for RS-232C)
- I/O (input/output) expansion bus
- fits on a 4- by 7½-inch board that mounts directly to a 5¼- or 3½-inch floppy-disk drive

Disk-based software includes the Z-System DOS (disk operating system), a debugger, and HD64180 assembler.

While this is in fact a hardware project, true functionality would be an exercise left to you readers were it not for the operating system and BIOS (basic input/output system) specifically written and adapted to the SB180. The combination of the HD64180 and Z-System is what gives this tiny computer so much power. Much of the project description therefore has to be the software that uniquely sets performance levels far above traditional 8-bit computer designs. I don't want to diminish the significance of the hardware, but I am a realist.

This month, I'd like to describe the HD64180 chip and give an overview of the changing evolution of CP/M as it pertains to this project. After that, I'll describe the design of the SB180. Next month will be dedicated to the operating-system software and BIOS.

CP/M AND BEYOND

Anyone who has been involved with microcomputers for more than two years acknowledges the tremendous impact of CP/M upon the history of personal computing. While hobbyists were still debating whether the "standard" tape format should be Kansas City CUTS (cassette user tape system) or Tarbell, Gary Kildall made CP/M available at a reasonable price. It quickly became the de facto standard DOS for 8080- and Z80-based microcomputers. With a "standard" operating system and a "standard" 8-inch disk format, entrepreneurial program-

Photo 2: *The* SB180 *shown beside a* 3½-*inch disk drive and an* 8-*inch disk drive.*

mers saw the opportunity to write serious business applications that needed disk capability to be viable and that could be sold to thousands of CP/M machine owners.

The first major commercial release of CP/M was version 1.4. In an effort to fix some bugs and improve its file-handling capabilities and limits, it was upgraded first to version 2.0 and quickly to version 2.2. Version 2.2 has been a stable product that is familiar to most readers of BYTE. Version 3.0, or CP/M Plus, has been available for about two years, but it hasn't matched the popularity of version 2.2. While CP/M Plus does offer some advanced features, it is not significantly better than version 2.2.

CP/M has many quirks and shortcomings. Having to warm-boot the system when changing disks is a major inconvenience, and named directories would be more convenient than trying to remember disk designators and user-area numbers. Almost no file or system security is provided. CP/M 2.2 does not support redirection of I/O devices, as MS-DOS and UNIX do. Even the MS-DOS batch facility beats CP/M's more primitive Submit and XSUB two ways from Sunday; CP/M lacks conditional testing at the command level.

Many system integrators decry CP/M's lack of a good menu utility to integrate stand-alone, executable programs. Command-line editing is primitive, and multiple commands on one line would be appreciated; creating a single-name "alias" for multiple commands would be even better. Since CP/M has no search path (à la PC-DOS and UNIX), you must either keep multiple copies of often-used programs in many different user areas (wasting disk space) or patch CP/M with a software kludge to make user area 0 accessible from all user areas (even that doesn't help if you need to access a file from user area 3 while you are in user area 7). Many CP/M users supplement their system utilities with more useful public-domain programs like XDIR, DU, CRC, Help, Unerase, and Diff. It's too bad that CP/M wasn't upgraded more regularly so that it could have evolved into a more mature product.

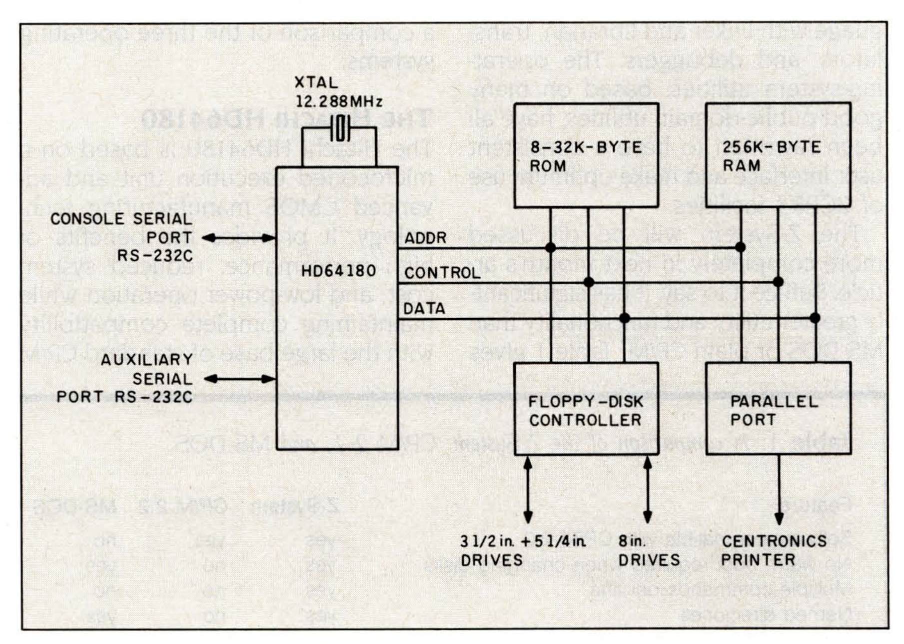


Figure 1: *Block diagram of the* SB180 *single-board computer.*

These observations are certainly not unique. When millions of people use a computer and its operating system in an attempt to become more productive in some way, obstacles to efficiency and productivity are bound to show up. Computer users who have had experience with many different operating systems will miss certain features to which they had become accustomed. And creative individuals of all types always can think of a "better way" to perform some function already provided.

One of the best-known attempts to improve CP/M was ZCPR (Z80 command processor replacement), developed under the direction of Rick Conn. ZCPR was written to replace the console command processor (CCP) supplied with CP/M. This public-domain software featured scaled-down features of UNIX appropriate for a single-user CP/M system. However, since it was designed to fit into the same 2K-byte space as the CCP, it was limited in what it could offer. It did make user area 0 "public" so that executable programs there could be invoked from other user areas. It also changed the prompt so that it indicated the user area as well as the drive currently logged in. As a result of user feedback, ZCPR2 evolved as an extended version of ZCPR. However, it required much more technical sophistication to install it into a CP/M system, and it started patching into and replacing parts of CP/M itself.

Within the past year, Echelon Inc. released ZCPR3, a much-improved version of ZCPR2, which provides solutions to all the problems with CP/M 2.2 and adds more features. Echelon has also developed a complete replacement for CP/M 2.2 in the form of the Z-System. It is composed of two major sections: ZCPR3 and ZRDOS. ZRDOS completely replaces CP/M's BDOS (basic disk operating system).

Written entirely in Z80 assembly language, the Z-System offers the benefits derived from the expanded Z80 instruction set (CP/M is 8080 code only) and from fixing bugs in CP/M 2.2 itself. It is downward-compatible with all CP/M software and takes advantage not only of the Z80 instruction set but of the Hitachi HD64180 CPU as well. Echelon provides both the operating system and a macro-relocating assembly lan-

(continued)

guage with linker and librarian, translators, and debuggers. The operating-system utilities, based on many good public-domain utilities, have all been rewritten to have a consistent user interface and make optimum use of ZCPR3 facilities.

The Z-System will be discussed more completely in next month's article. Suffice it to say, it has significantly greater utility and functionality than MS-DOS or plain CP/M. Table 1 gives a comparison of the three operating systems.

THE HITACHI HD64180

The Hitachi HD64180 is based on a microcoded execution unit and advanced CMOS manufacturing technology. It provides the benefits of high performance, reduced system cost, and low-power operation while maintaining complete compatibility with the large base of standard CP/M software. The HD64180 can be combined with CMOS VLSI (very-large-scale integration) memories and peripheral devices to form the basis for process-control applications requiring high performance, battery-power operation, and standard software compatibility.

Performance is derived from a high clock speed (6 MHz now, 9 MHz in the near future), instruction speedup, and an integrated memory-management unit (MMU) with 512K bytes of memory address space. The instruction set is a superset of the Z80 instruction set; 12 new instructions include hardware multiply, DMA (direct memory access), I/O, TEST, and a SLEEP instruction for low-power operation.

The HD64180 requires operation at specific frequencies in order to generate standard data-transmission rates. The standard operating frequency for the SB180 is 6.144 MHz (12.288-MHz crystal). Other frequencies that maintain standard data-transmission rates are 3.072 MHz, 4.608 MHz, and (later) 9.216 MHz.

System costs are reduced because many key system functions have been included on this 64-pin chip. Table 2 compares the HD64180 with other 8-bit processors.

The block diagram in figure 2 shows that the HD64180 CPU is composed of five functional blocks:

- Central processing unit: The CPU is microcoded to implement an upward-compatible superset of the Z80 instruction set. Besides the 12 new instructions, many instructions execute in fewer clock cycles than on a standard Z80.
- Clock generator: This generates the system clock from an external crystal or external clock input. The clock is programmably prescaled to generate timing for the on-chip I/O and system-support devices.
- Bus-state controller: This controller performs all status/control bus activity, including external bus-cycle wait-state timing, RESET, DRAM (dynamic RAM) refresh, and master DMA bus exchange. It generates "dual-bus" control signals for compatibility with

Table 1: A *comparison of the Z-System,* CP/M 2.2, *and* MS-DOS.

Feature	Z-System	CP/M 2.2	MS-DOS
Software-compatible with CP/M 2.2	yes	yes	no
No warm boot required when changing disks	yes	no	yes
Multiple commands per line	yes	no	no
Named directories	yes	no	yes
Password protection for directories	yes	no	no
Dynamically variable user privilege levels for commands	yes	no	no
Searching of alternate directories for invoked programs and files	yes	no	partial
Terminal-independent video capabilities	yes	no	no
Input/output redirection	yes	no	yes
Conditional testing and execution at the operating-system level (IF/ELSE/ENDIF)	yes	no	no
Shells and menu generators with shell variables	yes	no	no
Tree-structured on-line help and documentation subsystem	yes	no	no
512-megabyte file sizes, 8-gigabyte disks	yes	no	no
Complete error trapping with recovery, customizable messages, and prompts	yes	no	no
Screen-oriented file manipulation and automatic archiving and backup	yes	no	no
Full-screen command-line editing with previous-command recall and execution	yes	no	no

Table 2: A *comparison of some 8-bit processors.*

	HD64180	8080/85/Z80	NSC800	Z800	80188
Process	CMOS	NMOS	CMOS	NMOS	NMOS
Power	100 mW	1 W	100 mW	2 W	2 W
Maximum clock	10 MHz	8 MHz	4 MHz	10 MHz	8 MHz
Address space	512K bytes	64K bytes	64K bytes	512K bytes	1 megabyte
UARTs	2-ch.	no	no	1-ch.	no
DMAC	2-ch.	no	no	4-ch.	2-ch.
Timers	2-ch.	no	no	4-ch.	2-ch.
Clocked SI/O	yes	no	no	no	no
CS/wait logic	yes	no	no	yes	yes
DRAM refresh	yes	yes (Z80)	no	yes	no

Note: The availability of the Zilog Z800 is unknown, and specifications on it are subject to change.

both 68xx and 80xx family devices.

- Interrupt controller: The interrupt controller monitors and gives priorities to the four external and eight internal interrupt sources. A variety of interrupt-response modes are programmable.
- Memory-management unit: The MMU maps the CPU's 64K-byte logical-memory address space into a 512K-byte physical-memory address space. The MMU organization preserves software object-code compatibility while providing extended memory access and uses an efficient common area/bank area scheme. I/O accesses (64K bytes of I/O address space) bypass the MMU.

The integrated I/O resources comprise the remaining four functional blocks:

- Direct-memory-access controller (DMAC): The two-channel DMAC provides high-speed memory-to-memory, memory-to-I/O, and memory-to-mem-

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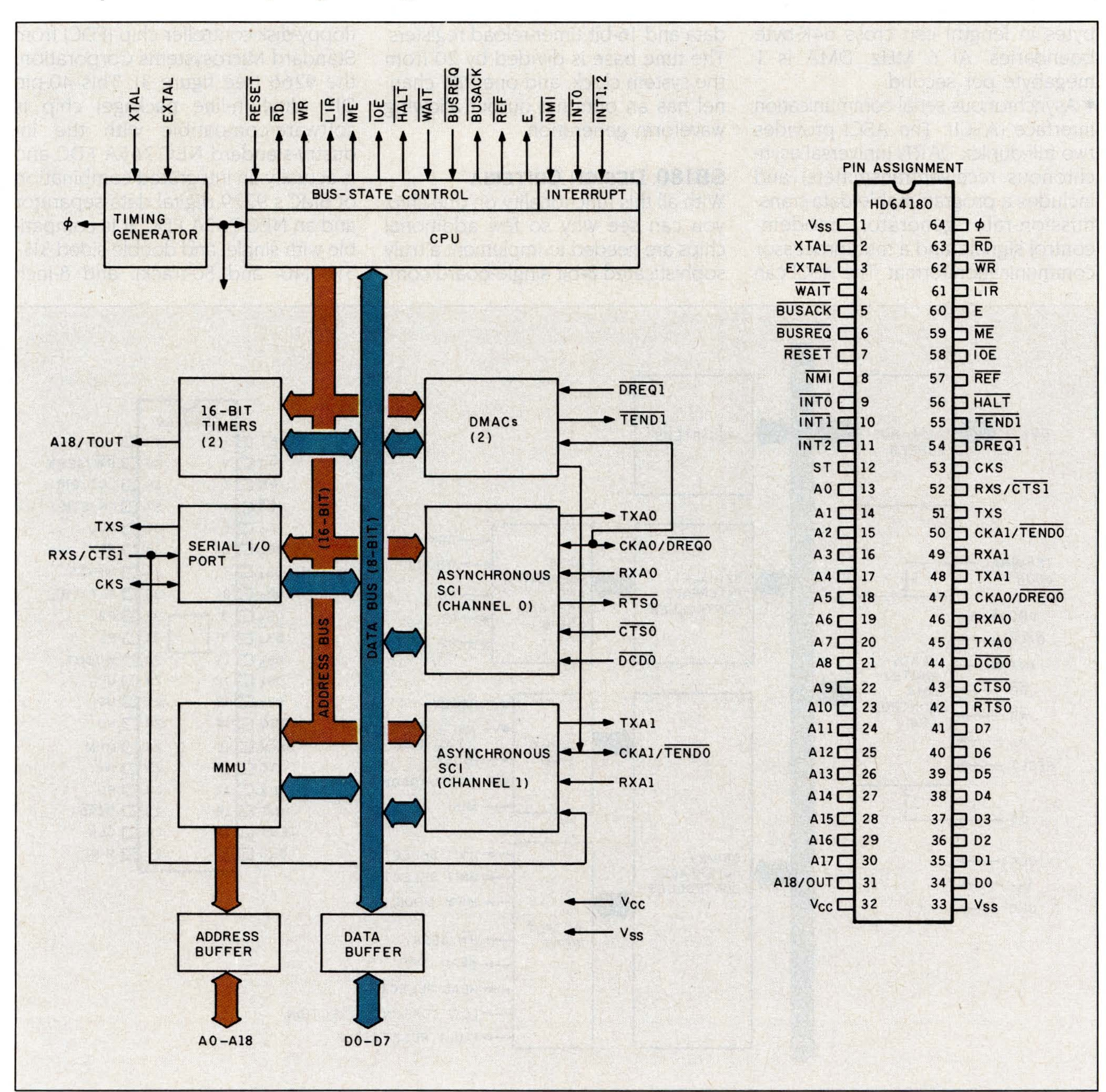


Figure 2: *Block diagram and pin-out of the* Hitachi HD64180.

ory-mapped-I/O transfer. The DMAC features edge or level sense-request input, address increment/decrement/ no change, and (for memory-to-memory transfer) programmable-burst or cycle-steal transfer. In addition, the DMAC can directly access the full 512K bytes of physical-memory address space (the MMU is bypassed during DMA) and transfers (up to 64K bytes in length) can cross 64K-byte boundaries. At 6 MHz, DMA is 1 megabyte per second.

• Asynchronous serial communication interface (ASCI): The ASCI provides two full-duplex UARTs (universal asynchronous receiver/transmitters) and includes a programmable data-transmission-rate generator, modem-control signals, and a multiprocessor communication format. The ASCI can use the DMAC for high-speed serial data transfer, reducing CPU overhead.

• Clocked serial I/O port (CSI/O): The CSI/O provides a half-duplex clocked serial transmitter and receiver. This can be used for high-speed connection to another microcomputer.

• Programmable reload timer (PRT): The PRT contains two separate channels, each consisting of 16-bit timer data and 16-bit timer-reload registers. The time base is divided by 20 from the system clock, and one PRT channel has an optional output allowing waveform generation.

SB180 Design Criteria

With all this functionality on one chip, you can see why so few additional chips are needed to implement a truly sophisticated 8-bit single-board computer in such a small space (less than 30 square inches). In terms of the original Altair microcomputer of 10 years ago, the functionally equivalent machine would have taken about 35 S-100 boards for a total of 1750 square inches (and that's using 8K-byte memory boards!).

In order to reduce chip count further, I decided to use an enhanced floppy-disk-controller chip (FDC) from Standard Microsystems Corporation, the 9266 (see figure 3). This 40-pin DIP (dual in-line package) chip is software-compatible with the industry-standard NEC 765A FDC and is actually an integrated combination of SMC's 9229 digital data separator and an NEC 765A FDC. It is compatible with single- and double-sided 3½-, 5¼- (40- and 80-track), and 8-inch

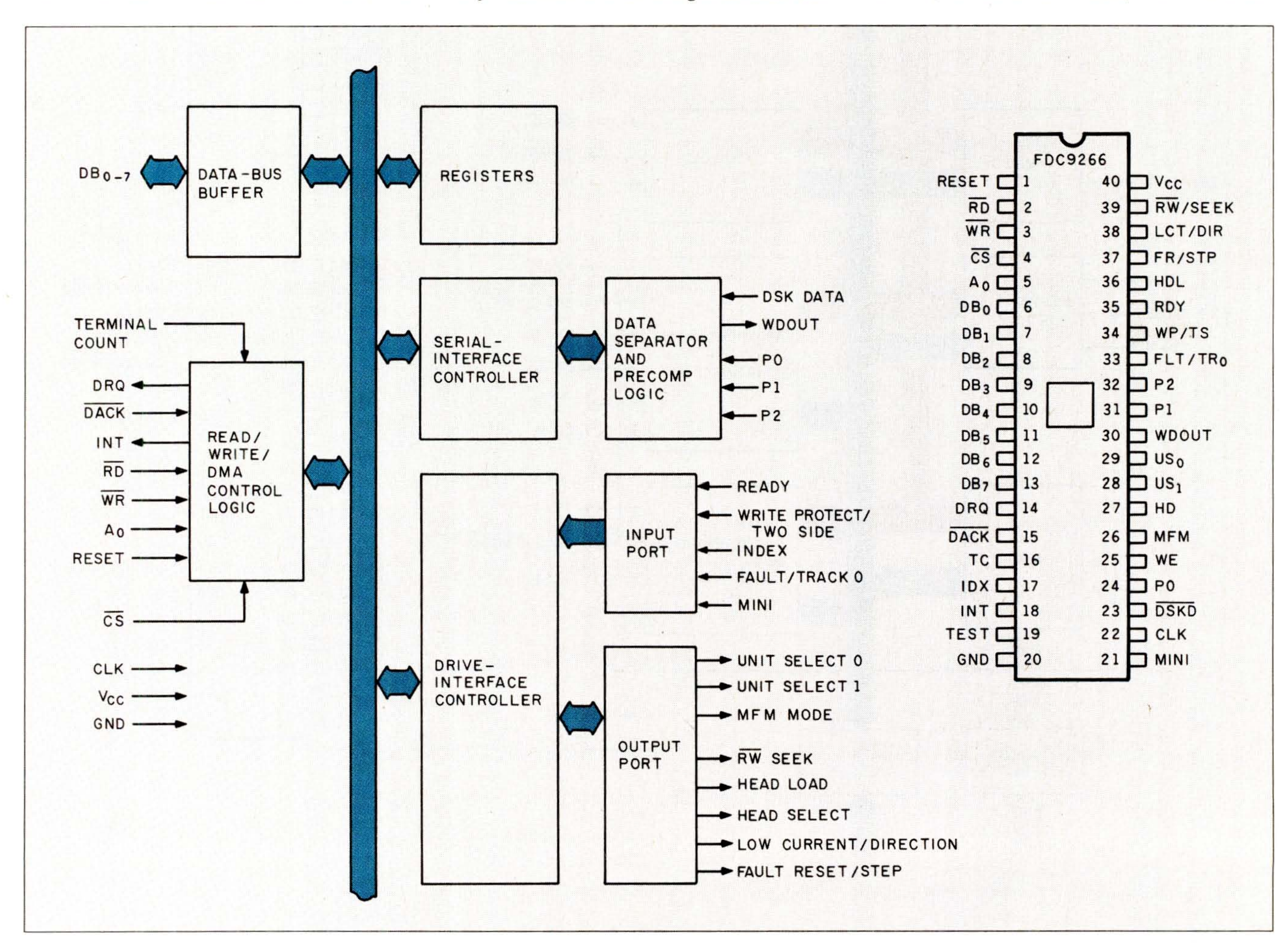


Figure 3: *Block diagram and pin-out of* SMC's 9266.

drives; the data separator handles both single- and double-density data. This means that it can be programmed to read and write most soft-sectored CP/M disk formats.

With the HD64180's two-channel ASCI built in, two serial ports were included in the design automatically. Provision was made for a Centronics parallel printer port as well. Since 256K-bit DRAM chips are now plentiful and inexpensive, eight were used for memory (64K-bit DRAMs can also be used). Because only 64K bytes is used for the logical-memory address space, you can optionally designate the other 192K bytes as a RAM disk in the operating system, or you may prefer to use if for other purposes (such as implementing banked memory for CP/M Plus).

THE SB180 HARDWARE

Figure 4 is the schematic diagram of the SB180 computer. Its design is primarily characterized by the high-performance, high-density MOS (metal-oxide semiconductor) devices, including 256K-bit DRAMs.

In addition to the CPU elements previously discussed, the SB180 system design implements the following functional blocks: RS-232C interface, memory interface, Centronics printer interface, floppy-disk interface, XBUS expansion bus, and power supply.

RS-232C INTERFACE

The HD64180 ASCI two-channel UART is connected to 1488/1489 RS-232C line drivers/receivers to provide two separate ports. ASCI channel 1 is used for the console; ASCI channel 0 is used for auxiliary RS-232C devices like printers, plotters, and modems. This distinction is made because modems require the extra handshake signals that are available with ASCI channel 0, while terminals do not. All primary RS-232C parameters (data-transmission rate, handshaking, data format, interrupts) are software-programmable.

MEMORY INTERFACE

The SB180 incorporates a 28-pin boot-ROM socket that can be jumpered to hold 8K by 8-bit, 16K by 8-bit, and 32K by 8-bit memory devices. The boot ROM (contains disk boot and ROM monitor) occupies the bottom 256K bytes of the HD64180 physical-memory address space since it is selected whenever A18/TOUT is low. (Note: The TOUT timer output function is not used.) Thus, the boot-ROM contents (whatever the size) are simply repeated in the lower 256K bytes. The boot-ROM output ($\overline{OE}$) is enabled by the HD64180 $\overline{ME}$ (memory enable) signal. (As configured, the maximum RAM on the SB180 is 256K bytes. To support larger memories, additional address decoding would be required to designated RAM and ROM areas in the current 256K-byte boot-ROM space.)

ROMs of 200 nanoseconds (and, marginally, 250 ns) can operate with one wait state.

At $\overline{RESET}$, the HD64180 begins execution at physical address 00000, the start of the boot ROM. [*Editor's note: All addresses are in hexadecimal.*]

256K-BIT DYNAMIC RAM

Standard 256K-bit 150-ns DRAMs, requiring 256 refresh cycles (8-bit refresh address) every 4 milliseconds (ms) are used. These DRAMs occupy the top 256K bytes of the HD64180 512K-byte physical-memory address space.

The interface is quite straightforward. Complete DRAM refresh control is provided by the HD64180 in conjunction with control logic IC14 and IC22 and address multiplexers IC11, IC12, and IC13.

The HD64180 $\overline{WR}$ output directly generates DRAM $\overline{WE}$. The HD64180 $\overline{ME}$ output directly generates $\overline{RAS}$. During normal read/write cycles (A18 high, $\overline{REF}$ high), $\overline{CAS}$ goes low at the next rising edge of ϕ following the rising edge of E (enable). This provides plenty of setup time for the address multiplexers since the rising edge of E switches the address multiplexers from row to column addresses.

$\overline{RAS}$-only refresh is used. The HD64180 generates the refresh addresses. During refresh cycles ($\overline{REF}$ low), $\overline{ME}$ generates $\overline{RAS}$, while $\overline{CAS}$ is suppressed at IC22.

The HD64180 can be programmed to generate refresh cycles every 10, 20, 40, or 80 ϕ cycles as well as selecting a refresh every two or three clock cycles. Since the DRAM requires a refresh cycle every 15.625 microseconds (μs) (4 ms/256), the HD64180 is programmed for 80-cycle refresh request since $80 \times (1/6.144 \text{ MHz}) = 13.02\ \mu s$. Two-cycle refresh is also programmed. Thus, refresh overhead is only 2.5 percent (2 cycles every 80 cycles).

CENTRONICS PRINTER INTERFACE

The Centronics printer interface is composed of the 8-bit latch IC9 and flip/flop IC10. The Centronics port is decoded at I/O address 0C0 by IC26. To write to the printer, the following sequence is used:

Write data to port 0C1

This sets up the data to the printer and asserts $\overline{STB}$ low. The following sequence:

Write data to port 0C0

deasserts the printer $\overline{STB}$ signal high.

When the printer has processed the data, it will return the $\overline{ACK}$ signal, which generates an external interrupt ($\overline{INT\ 1}$) to the HD64180. The interrupt handler clears the interrupt by performing a dummy output to port 0C0. This clears the $\overline{INT\ 1}$ interrupt request.

The printer interface is not buffered, so compatibility with all printer/cable setups cannot be guaranteed. In practice, however, problems should be rare since the software scheme provides adequate data-setup and -hold times. Also, note that this printer interface is interrupt-driven, which allows high-performance operation. In a more primitive polling design, excessive overhead limits acceptable performance in applications like background print spooling.

FLOPPY-DISK INTERFACE

SMC's 9266 FDC manages almost all details of the drive interface, including data separation and (with external logic IC22 and IC23) programmable

(continued)

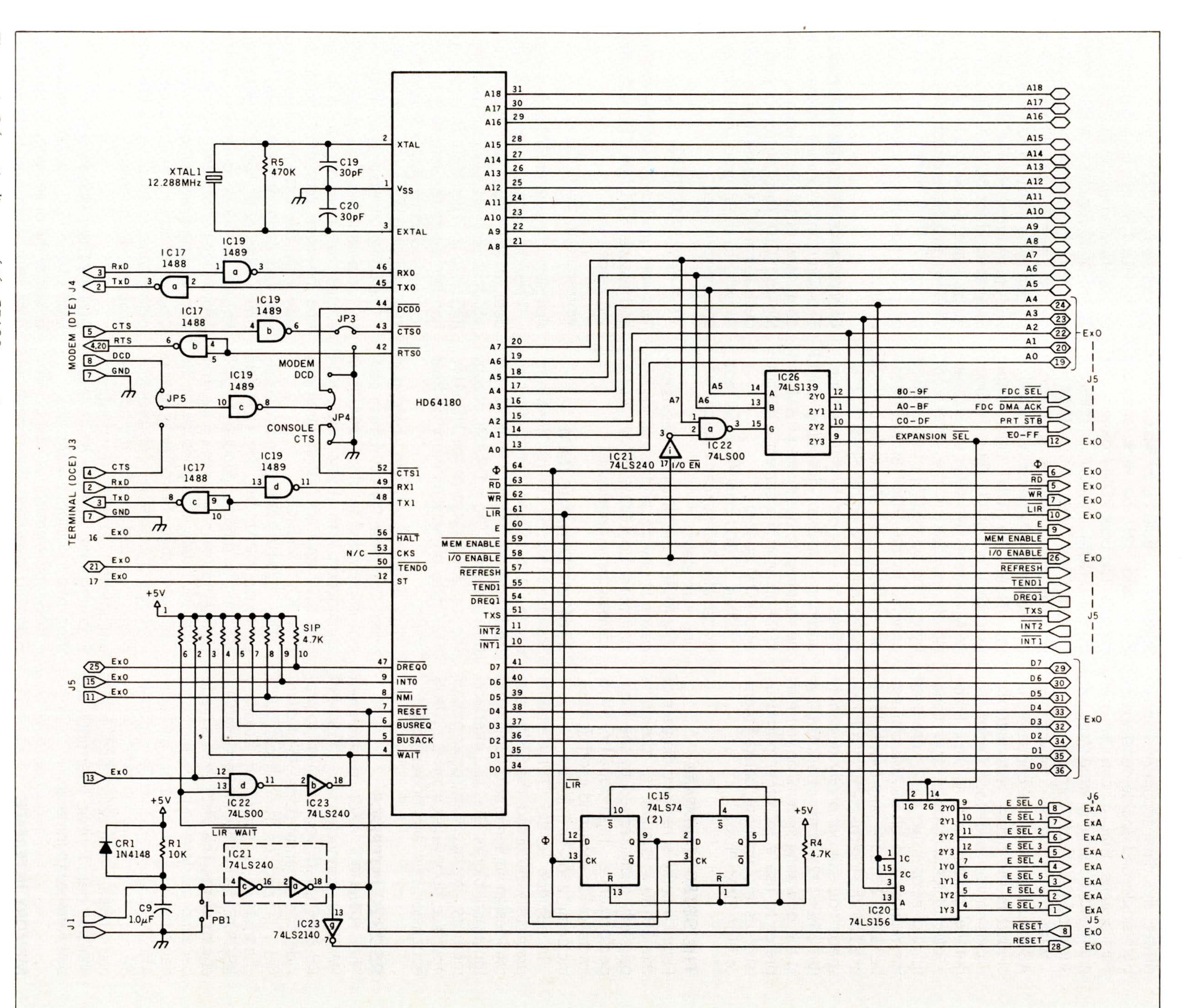


Figure 4: *Schematic diagram of the SB180 computer.*

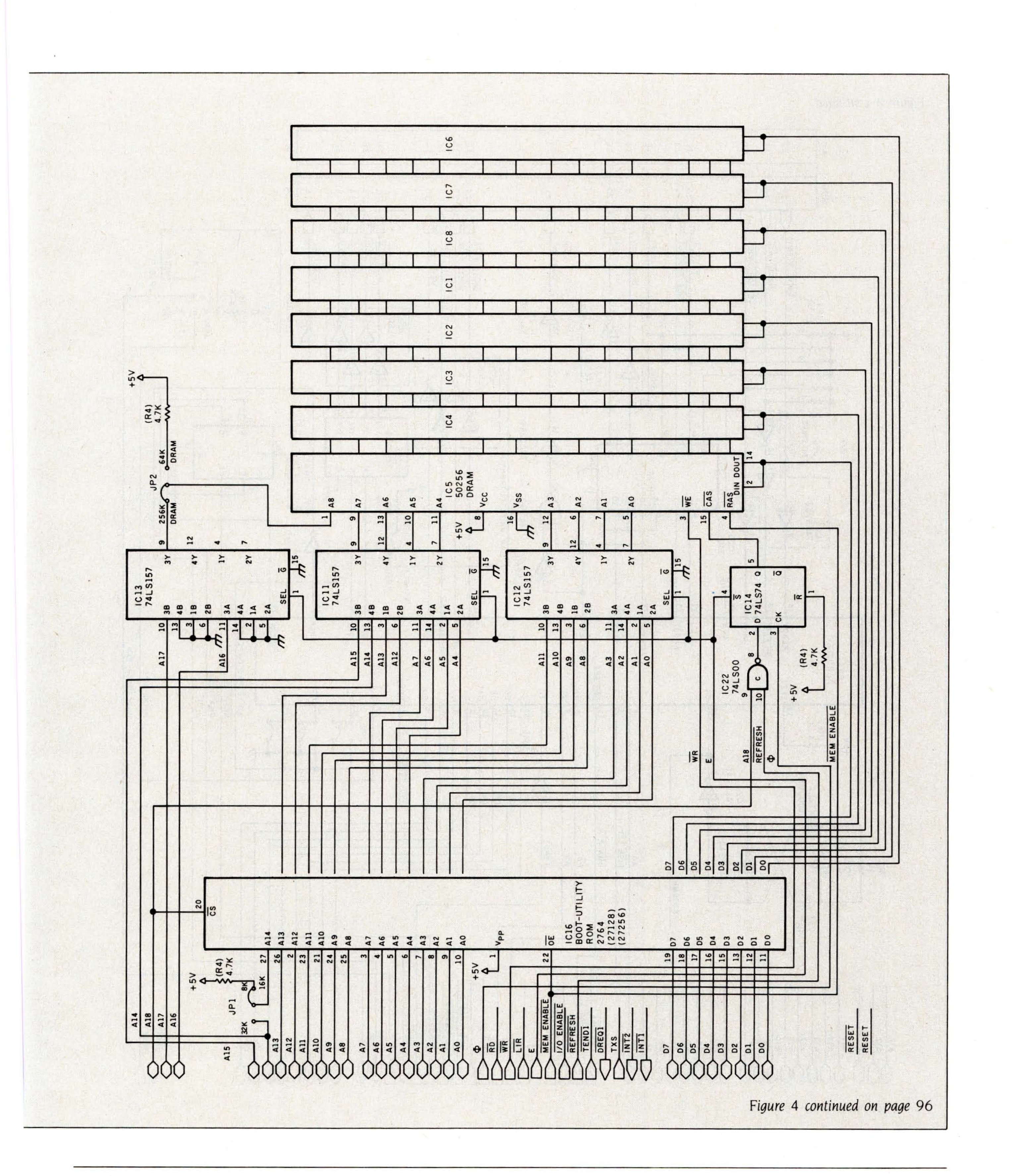


Figure 4 continued on page 96

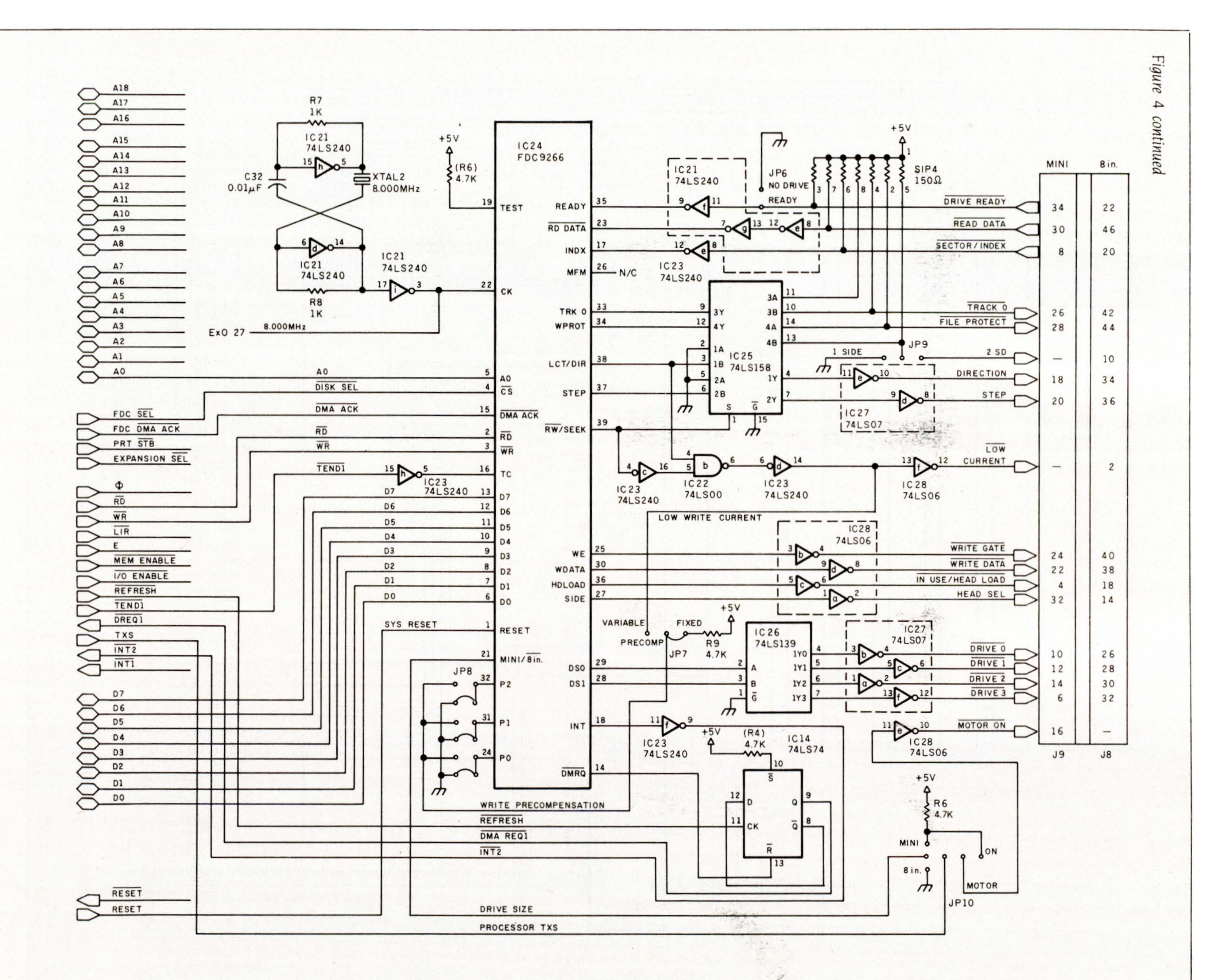
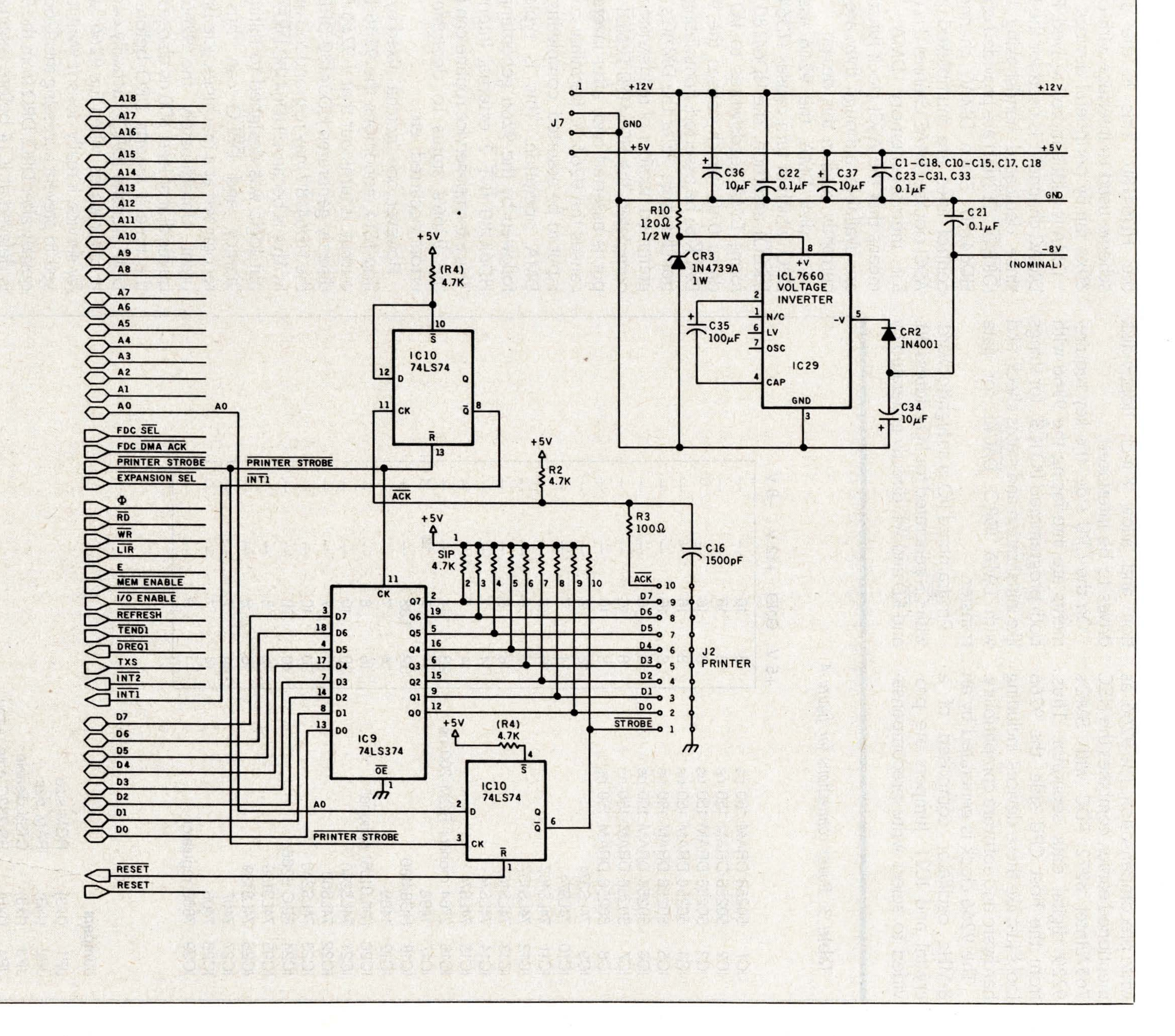


Figure 4 continued



A18
A17
A16
A15
A14
A13
A12
A11
A10
A9
A8
A7
A6
A5
A4
A3
A2
A1
A0
FDC SEL
FDC DMA ACK
PRINTER STROBE
EXPANSION SEL
Φ
RD
WR
LIR
E
MEM ENABLE
I/O ENABLE
REFRESH
TEND1
DREQ1
TXS
INT2
INT1
D7
D6
D5
D4
D3
D2
D1
D0
RESET
RESET
A0
PRINTER STROBE
INT1
ACK
+5V
(R4)
4.7K
IC10
74LS74
S
D
CK
Q
R
+5V
R2
4.7K
R3
100Ω
C16
1500pF
SIP
4.7K
IC9
74LS374
CK
OE
Q7
Q6
Q5
Q4
Q3
Q2
Q1
Q0
ACK
D7
D6
D5
D4
D3
D2
D1
D0
STROBE
J2
PRINTER
IC10
74LS74
A0
PRINTER STROBE
J7
+12V
GND
+5V
+12V
+5V
GND
C36
10µF
C22
0.1µF
C37
10µF
C1–C18, C10–C15, C17, C18
C23–C31, C33
0.1µF
C21
0.1µF
-8V
(NOMINAL)
R10
120Ω
1/2W
CR3
1N4739A
1W
ICL7660
VOLTAGE
INVERTER
+V
N/C
LV
OSC
CAP
-V
GND
IC29
C35
100µF
CR2
1N4001
C34
10µF

write precompensation. The 9266, as mentioned earlier, combines the NEC 765A/Intel 8272 FDC with SMC's 9229 digital data separator. Thus, from the host CPU side, the 9266 looks just like these devices, including hardware and software compatibility.

The 9266 clock is generated by an 8-MHz oscillator composed of a crystal and IC21. Jumpers are provided to select write precompensation and allow 8-inch floppy-disk drives to be interfaced.

On the CPU side, the key requirements are interfacing the 9266 with both programmed I/O (CS), for things like initialization and status check, and with DMA (DRQ, DACK), for data transfer.

Programmed I/O is straightforward, with CS generated for I/O address 80, and RD and WR directly generated by the HD64180. This is the same scheme used to interface with other 80xx family peripheral devices.

DMA is a little more involved. First, DMAC channel 1 is used for the FDC since dedicated handshaking lines (DREQ1, TEND1) are provided on the HD64180. Since DMAC channel 0 control lines are multiplexed (with ASCI clocks), DMAC channel 0 is used for memory-memory DMA. This means that the ASCI clock functions are available, although they are not currently used in this design.

For disk DMA, the 9266 asserts DRQ, which in turn causes HD64180 DREQ1 assertion. The HD64180 performs DMA reads/writes to I/O address 0A0, which causes the 9266 DACK to be asserted, completing the transfer cycle. After the DMAC's programmed number of reads/writes has completed, the HD64180 TEND1 output is asserted and, after inversion, causes the 9266 TC (terminal count) input to be asserted, completing the DMA operation. This is typically followed by the 9266 generating an HD64180 INT 2 external interrupt. This interrupt-service routine can read the 9266's status to determine if errors occurred, etc.

However, one "gotcha," fixed by flip/flop IC14, conditions the 9266 DRQ output. It turns out that if 9266 DRQ directly generates HD64180 DREQ1, the HD64180 may respond too quickly. This is because HD64180 DREQ input logic was designed to minimize latency, and DREQ can thus be recognized at a machine-cycle breakpoint. Unfortunately, the 9266 requires that at least 800 ns elapse from the time it asserts DRQ before the DMA transfer (DACK) actually occurs. In other words, when the 9266 "asks" for service, it really doesn't want it . . . yet! To prevent accessing the 9266 too quickly after DRQ, DRQ from the 9266 is delayed at IC14 before issuing the DREQ1 to the HD64180. DRQ is delayed by one REF cycle time.

Minifloppy double-density data transfers occur at a 250-kilohertz (kHz) data rate. Thus, each byte must be read within 32 μs. The disk-driver software reprograms the refresh-

Table 3: *Power connections for figure 4.*

		+5 V	GND	+12 V	−8 V
IC1	50256 DRAM 150 ns	8	16	—	—
IC2	50256 DRAM 150 ns	8	16	—	—
IC3	50256 DRAM 150 ns	8	16	—	—
IC4	50256 DRAM 150 ns	8	16	—	—
IC5	50256 DRAM 150 ns	8	16	—	—
IC6	50256 DRAM 150 ns	8	16	—	—
IC7	50256 DRAM 150 ns	8	16	—	—
IC8	50256 DRAM 150 ns	8	16	—	—
IC9	74LS374	16	8	—	—
IC10	74LS74	14	7	—	—
IC11	74LS157	16	8	—	—
IC12	74LS157	16	8	—	—
IC13	74LS157	16	8	—	—
IC14	74LS74	14	7	—	—
IC15	74LS74	14	7	—	—
IC16	2764 monitor ROM 200 ns	28	14	—	—
IC17	1488	—	7	14	1
IC18	HD64180	32	1,33	—	—
IC19	1489	14	7	—	—
IC20	(74LS156) optional	16	8	—	—
IC21	74LS240	20	10	—	—
IC22	74LS00	14	7	—	—
IC23	74LS240	20	10	—	—
IC24	FDC 9266	40	20	—	—
IC25	74LS158	16	8	—	—
IC26	74LS139	16	8	—	—
IC27	7407	14	7	—	—
IC28	7406	14	7	—	—
IC29	7660 regulator	—	3	—	—

Jumpers

JP1	(1x3)	ROM size
JP2	(1x3)	RAM size
JP3	(1x3)	CTS0 disable
JP4	(1x5)	RS-232C gate output
JP5	(1x3)	RS-232C gate input
JP6	(1x2)	Drive without ready
JP7	(1x3)	Write precomp mode
JP8	(2x6)	Write precomp value
JP9	(1x3)	Single-/double-sided drive
JP10	2 – 1x3	TXS function/drive size

request rate from every 80 ϕ cycles to every 40 ϕ cycles prior to disk DMA and reassigns it back to 80 ϕ cycles after the disk DMA is completed. The 9266 DRQ is delayed from between 40 ϕ cycles to 79 ϕ cycles. This is about 6 to 14 μs. Therefore, the 800-ns delay and 32-μs data-transfer constraint are both met. Note that 8-inch floppy double-density data transfer is twice as fast (500 kHz) and requires a refresh-rate increase to every 20 ϕ cycles.

EXPANSION BUS

The spare $\overline{\text{CS}}$ from address decoder IC26 (I/O addresses 0E0 to 0FF) and all major buses (address, data, control) are routed to the expansion bus. This allows an I/O expansion-board capability. The full complement of HD64180 control signals ($\overline{\text{IOE}}$, E, $\overline{\text{RD}}$, $\overline{\text{WR}}$, etc.) allows easy interface to all standard peripheral LSI (large-scale integration) devices, including the 80xx, 68xx, and 65xx families. Example expansion boards could include a hard-disk controller, 1200-bits-per-second (bps) modem, or LAN (local-area network) interface.

POWER SUPPLY

The SB180 requires +5-V and +12-V power. A negative voltage is generated on board, which is used only by the RS-232C driver. The negative voltage is obtained by using a Zener diode to obtain +9 V from +12 V, which is then inverted using an Intersil 7660 converter. The +12-V power is used only for the RS-232C driver. Thus, the SB180 uses only significant power from the +5-V supply. Typically, this may be from 0.3 to 0.6 ampere (A) (depending on the proportion of the TTL [transistor-transistor logic] and memory devices that are CMOS)—about the same as a 5¼-inch floppy disk.

THE SB180 ROM MONITOR

While my initial discussion espoused the merits of the Z-System, every good single-board computer needs a ROM monitor that should be more useful than just booting the operating system from a floppy disk. The SB180 8K-byte ROM monitor includes commands for everything you need—from A to Z. It is supplied on an 8K-byte EPROM. (The SB180 also supports 16K- and 32K-byte ROMs, so additional commands or application programs can be supported.)

A ASCII table: Prints an ASCII table
B Bank select: Selects a 64K-byte memory bank
C Copy disk: Systems with 256K bytes of RAM can perform single-drive copies
D Display memory: Displays memory in hexadecimal and ASCII
E Emulate terminal: Console keyboard is echoed to the auxiliary RS-232C output, and the RS-232C input is echoed on the console display
F Fill memory: Any portion of memory is filled with a data byte
G Go to program: Starts program execution at specified address and optionally includes a breakpoint
H Hexmath: Prints the 20-bit sum and difference and 32-bit product of the two arguments
I Input port: Prints the 8-bit data input from specified port
K Klean disk: Formats a specified drive
M Move memory: Moves a block of memory
N New command: Enables new commands from extended ROM space
O Output port: Byte is output to specified port address
P Printer select: Toggles printer selection between the Centronics parallel port and the auxiliary RS-232C port
Q Query memory: Searches memory for pattern of 1 to 4 bytes
R Read disk: Reads specified sectors from drive into memory
S Set memory: Displays memory contents and allows new data to be entered
T Test system: Tests various system devices
U Upload hexadecimal file: Uploads Intel hexadecimal file from auxiliary or console serial port
V Verify memory: Compares two blocks of memory
W Write disk: Writes specified sectors to disk from memory
X eXamine CPU registers: Displays main and alternate CPU registers and prompts for modification of main registers
Y Yank I/O registers: Displays the HD64180 on-chip I/O registers
Z Z-System boot: Boots the Z-System from disk

Figure 5: *A list of the monitor commands.*

The SB180 ROM monitor provides commands to assist the design and debugging of SB180-related hardware and software. Also, it serves as a stand-alone training vehicle for the HD64180 CPU.

The monitor supports the following I/O devices:

CON: Console RS-232C serial port
AUX: Auxiliary RS-232C serial port
CEN: Centronics parallel printer port
DSK: Floppy-disk storage devices

The monitor supports one to four 5¼-inch, 48- or 96-tpi (tracks per inch), 40- or 80-track, double-sided double-density disk drives. During initial system checkout, such a drive should be connected to verify operation of the disk interface.

At $\overline{\text{RESET}}$, the monitor first checks for fatal RAM failure. If the RAM is bad, the monitor waits for a carriage return to be typed on the console in order to determine the console data-transmission rate and then prints 8 binary digits—each corresponding to one DRAM chip. A chip associated with a 1 is faulty. The RAM-check se-

(continued)

quence is repeated each time a carriage return is typed.

If the RAM is okay, the stack is set up, and the monitor checks to see if a disk is loaded in drive #0. If so, the DOS boot-load sequence (same as the Z command) is started.

The monitor commands are shown in figure 5.

THE LUNCHBOX COMPUTER

The only things you need to turn the SB180 into a full-fledged stand-alone microcomputer are a +5-V and +12-V power supply (or a 12-V battery and 5-V regulator), at least one 5¼-inch floppy-disk drive (initially), and a serial terminal.

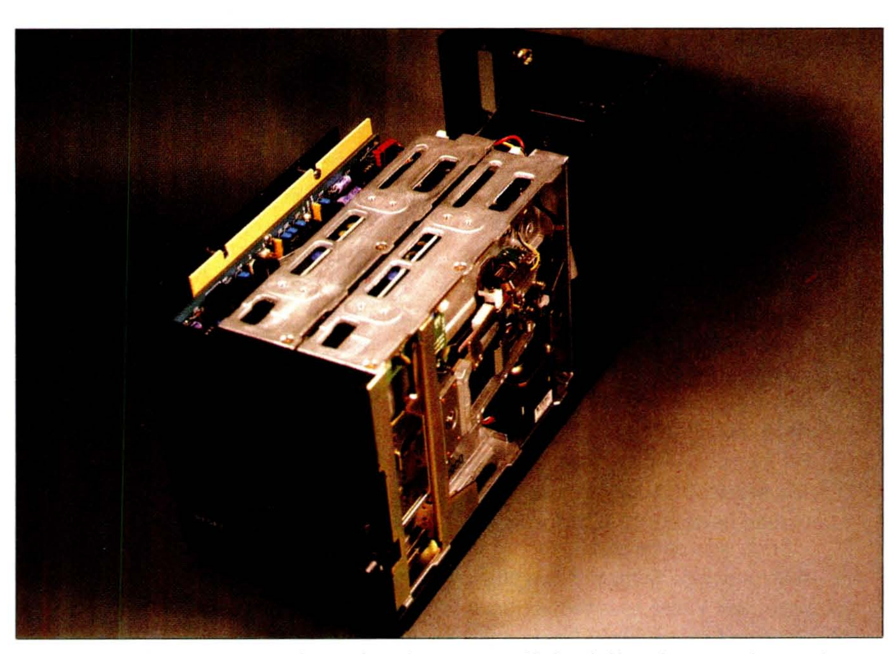


Photo 3: *The* SB180 *can be packaged in many off-the-shelf enclosures advertised in* BYTE. *It fits comfortably to the left of a pair of half-height* 5¼*-inch disk drives in a case available from* Disk Plus. *This enclosure also includes the power supply.*

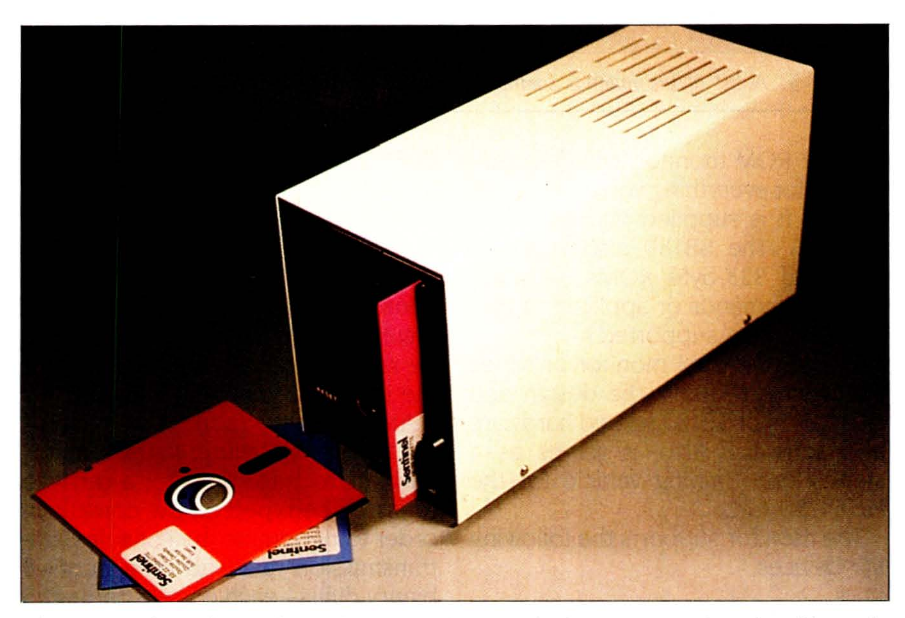


Photo 4: *The enclosure from photo* 3 *is shown with the cover on. The only additional hardware necessary to use the system is a serial terminal.*

You can mount such a small computer in many ways (see photos 3 and 4). If you use a half-height drive, the SB180 will fit on top of the drive inside a single full-height disk-drive chassis including power supply! Since the console serial port can automatically detect the terminal's data-transmission rate, you can carry your SB180 with you and connect it to any terminal (or computer emulating a terminal) running at 300, 1200, 9600, or 19,200 bps (other rates are optionally selected).

It is possible to fit the SB180, power supply, and two 3½-inch floppies into a lunchbox. If you want to get fancy, you could fit the SB180, power supply, one or two half-height floppies, the Micromint Term-Mite terminal board, and a keyboard into a small attaché case. Use any handy video monitor, and . . . voilà! You have just out-Osborned Adam Osborne!

I can imagine many unusual ways to package the SB180. When good LCDs (liquid-crystal displays) come down in price a bit more, I think the SB180 can form the basis of a functional notebook computer. The SB180 makes minimal use of the +12-V supply (and only for RS-232C operation) and can use less than 1 A at +5 V, so battery power is a real possibility. With just one floppy disk, the SB180 can become a super data logger. While my Z8 BASIC or FORTH single-board computer might ordinarily be used for such an application, not everyone likes to program in FORTH or BASIC. With a CP/M-compatible computer, a developer can now choose Pascal, C, FORTRAN, or even PL/I for applications. Since the data is already in CP/M format, it makes data analysis convenient.

The Z-System is provided with the complete SB180 board and software package. While it comes with a utility to read several other common 5¼-inch formats (like Kaypro and Osborne), its native format is identical to the well-optimized 386K-byte

double-sided double-density format of the Little Board from Ampro Inc. Provisions have been made to support 8-inch drives as well. Of course, it is possible to implement CP/M 2.2, CP/M Plus, MP/M II, TurboDOS, or Oasis if you prefer.

Although simple benchmarks are not to be taken as the last word in describing a computer's performance, I did run the BYTE Sieve of Eratosthenes prime-number program on the SB180 and the MPX-16 (8088-based with a 4.77-MHz clock, same as the IBM PC) using appropriate versions of Microsoft BASIC. For one iteration, the MPX using GW-BASIC took 203 seconds, while the SB180 using MS-BASIC took 147 seconds. An empty FOR . . . NEXT loop with 20,000 iterations took 27 seconds on the MPX and only 18 seconds on the SB180. Don't forget that these results are based on the 6-MHz implementation of the HD64180; with a 9-MHz clock, the results will be spectacular—not quite the speed of an IBM PC AT, but close!

EXPERIMENTERS

As always, I try to support the computer experimenter by rewarding diligence. If you build the SB180 from scratch, send me a picture, and I'll send you a copy of the BIOS and ROM monitor on disk (SB180 format, double-sided double-density) at no charge, provided it is for your personal use. A printed listing is available for a modest charge.

If you build, buy, or otherwise assemble an SB180 system, I would like to know about it. I will be designing expansion boards for the SB180 and can notify you of them in advance of publication. In addition, having your name will greatly simplify the organization of any users groups that might arise.

CIRCUIT CELLAR FEEDBACK

This month's Circuit Cellar Feedback is on page 416.

NEXT MONTH

In part 2 of this article, I'll describe the software for the SB180. ■

Special thanks to Tom Cantrell, Merrill Lathers, and Bob Stek for their contributions to this project.

The following items are available from

The Micromint Inc.
25 Terrace Dr.
Vernon, CT 06066
(800) 635-3355 for orders
(203) 871-6170 for information

1. SB180 computer board with 256K bytes of RAM. Complete with user's manual and ROM monitor.
   assembled and tested . . . SB180-1, $369
   complete kit SB180-2, $349
2. SB180 boot disk. Z-System DOS with limited utilities and BIOS. Provided on one 5¼-inch SB180 format double-sided double-density disk SB180-10, $49
3. Z-System, including ZRDOS, ZCPR3, an editor and utilities, ZAS assembler, BIOS source, and ZDM debugger. Complete with manuals. Provided on four 5¼-inch SB180 format double-sided double-density disks SB180-20, $190
4. HD64B180 chip (6 MHz) with data manual and 12.288-MHz XTAL $50
5. BYTE readers' special. Complete SB180 computer board with 256K bytes of RAM, user's manual, ROM monitor, and all the software listed in item 3. (Available through December 31, 1985.)
   assembled and tested . SB180-1-20, $499
   complete kit SB180-2-20, $479

All boards are complete with the exception of the 50-pin, 8-inch drive and 44-pin expansion headers, which are not populated. They are optionally available. Printer, power, disk, and terminal cables are available separately. Call for pricing.

Please include $10 ($7 less on item 4) for shipping and handling in the continental United States, $18 elsewhere. Connecticut residents please include 7.5 percent sales tax.

Editor's Note: Steve often refers to previous Circuit Cellar articles. Most of these past articles are available in book form from BYTE Books, McGraw-Hill Book Company, POB 400, Hightstown, NJ 08250.

Ciarcia's Circuit Cellar, Volume I covers articles in BYTE from September 1977 through November 1978. *Volume* II covers December 1978 through June 1980. *Volume* III covers July 1980 through December 1981. *Volume* IV covers January 1982 through June 1983.

To receive a complete list of Ciarcia's Circuit Cellar project kits, circle 100 on the reader-service inquiry card at the back of the magazine.

HOMEBASE . . . THE

From the desk
of **Alex Morton**,
VP Marketing & Sales
Amber Systems

Here's what noted science fiction writer David Gerrold wrote about Homebase!
A.M.

Dear Alex,

You asked for my reactions to the latest version of Homebase. Ok, here goes. But I'm afraid I can't give you too many suggestions on how to improve it. It's great!

Look, all I expected was a simple little calendar-calculator-notepad utility, and I would have been satisfied with that. What I found instead, is that Homebase is very much more. It has quickly become the single most indispensible piece of software that I own. It is easy to use and powerful without being intimidating. It is definitely one of those "how did I ever get along without this?" programs.

I use the calendar and address-book functions constantly, both at home and in my Kaypro 2000 when I'm travelling. It's like taking my whole office with me, but without the problems of dragging it around the airport, or trying to get it through customs.

The notepad functions are especially useful. What I like the best is that I can just open up a window and go to work without having to first learn a whole new language. My ideas are always close at hand and I can get to my notes quickly. PLUS I can pull out notes on any specific topic that I need. (Translation: It's a whole database system, without all the big words. I like this a lot.)

There are a lot of nifty little surprises here, too. There's a terrific alarm clock, a set of DOS Services that makes most of my utility programs obsolete, and a calculator that does everything but reheat my coffee. (Do you accept trade-ins of hand held calculators?)

The built-in terminal program ought to be called "an Excedrin Option" because it makes the headaches of using a modem disappear. I like the ease with which I can configure the system and store specific configurations. And I really like the background electronic mail; I didn't know it could be this easy or convenient. I also like being able to just open a small window to listen in on the Compuserve CB simulation while keeping my other work on screen.

I'm sorry that I haven't used the cut and paste function enough to rave about it. Who knows? Maybe this is the part of the program that I'll hate. So what. I still got my money's worth.

I hope you sell a zillion copies. And you should because the price is unbelievable. As far as I'm concerned, you've set a new standard for others to try to match. At $49.95, the program is certainly worth it, ten times over.

Sincerely,

David Gerrold

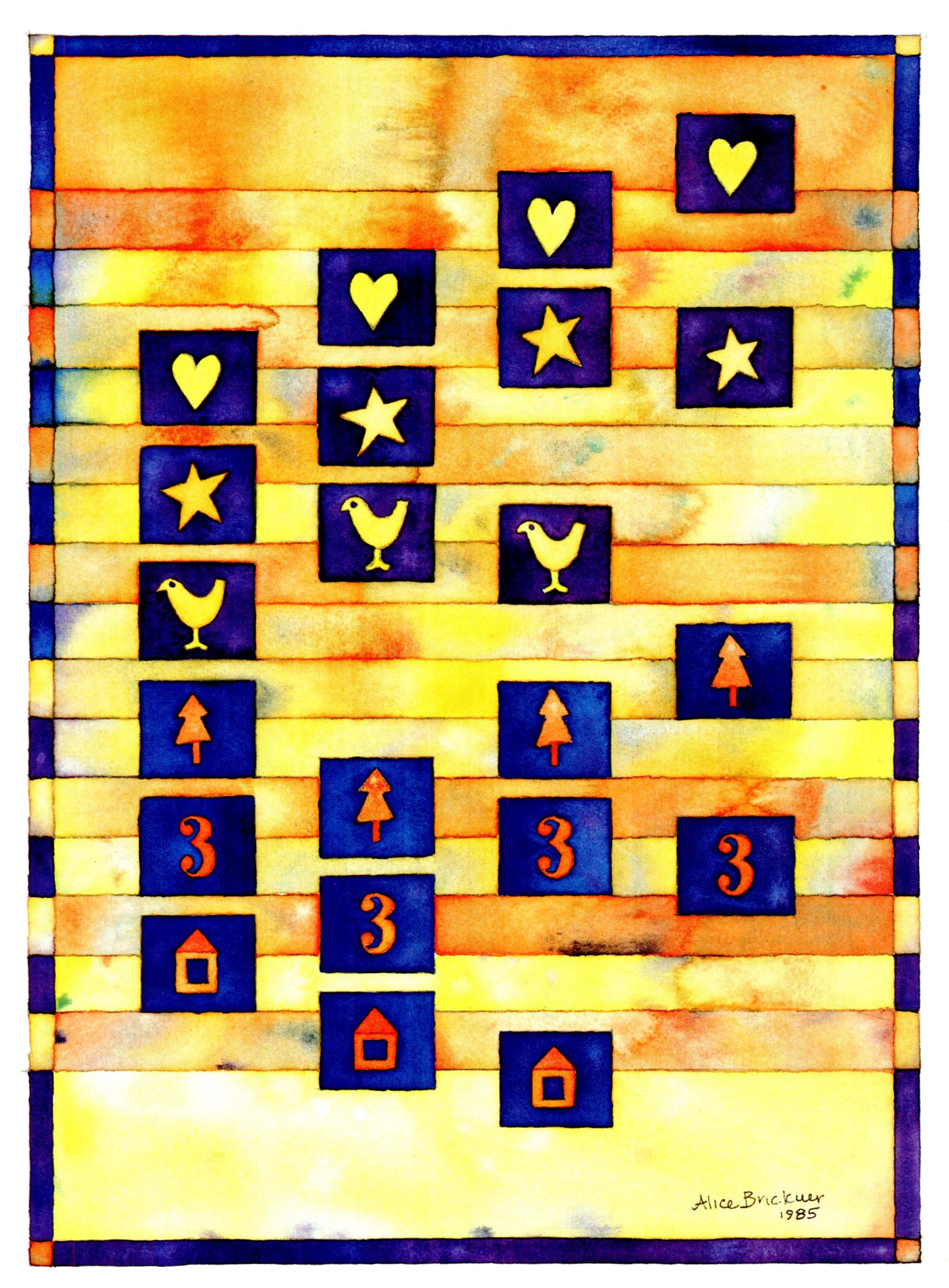
David Gerrold

David Gerrold is the award winning author of:

The World of Startrek, The Trouble with Tribbles, A Matter for Men, A Day for Damnation, the classic novel of artificial intelligence: **When Harlie was One,** and a frequent contributor to computer magazines.

HOMEBASE is designed to allow you to add additional tools, as your demands require them. That's why we've even made it ProKey compatible.

WE'VE BUILT A PROGRAM TO PROVIDE FOR YOUR FUTURE NEEDS AS WELL AS YOUR PRESENT ONES.

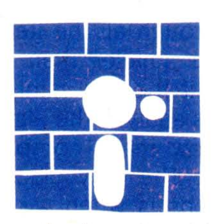


ILLUSTRATED BY ALICE BRICKNER

AN ANALYSIS OF SORTS

BY JONATHAN AMSTERDAM

How to choose one sorting algorithm over another



A friend told me recently that 90 percent of all the computer programs in the world sort. I can believe it. Our society's passion for organization has elevated the simple task of putting things in order to a position of major importance. And who better to carry out the job than those informational beasts of burden—computers?

Because of their significance, sorting algorithms have been thoroughly studied. Some are slow and some are fast. Some sort a few items and some sort millions of items. Here I want to discuss sorting in the context of three different algorithms: Selection Sort, for small lists, Quicksort, for larger lists, and Mergesort, for lists of a size so monstrous they can't fit into memory all at once. But first we will need to develop some simple tools to help us with our analysis of these algorithms.

ANALYSIS

Our goal is to understand the efficiency of some sorting algorithms. But we are immediately faced with a problem: How can we study an algorithm in the abstract without considering the language it's written in or the machine it's running on? For example, any algorithm written in a high-level language will run faster when written in assembly language. And any program running on a microcomputer would run faster on a mainframe. We want to abstract away from these facts, to talk about an algorithm's running time independent of machine or language.

Computer scientists have come up with some simple rules that make this possible. The first is to measure running time by the number of key operations used in the algorithm rather than by actual speed on some computer or by number of instructions executed. For example, in sorting, the two key operations are comparing two items and swapping their positions. The idea behind this rule is that any program that implements the algorithm, regardless of what language it's written in or what computer it's running on, will have to do the same number of key operations. The number of comparisons is usually a better indication of the running time because there will almost always be more comparisons than swaps in a sorting algorithm.

The second important rule is to measure an algorithm's speed in terms of the size of its input. In a way, this is just common sense; we wouldn't want to compare the

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running time of an algorithm sorting 10 things to another sorting 100 things. More likely, we would have some kind of table that compared the algorithms' times on lists of 10, 100, 1000, or more things.

But we'd actually want something more than a table. Ideally, we want a function that tells us, for any size input, what the running time will be. Then we can compare the rate of the functions' growth to see which does better in the long run. For example, the function $f(n) = n^2$ will "grow faster" than $g(n) = 100n$. That is, for sufficiently large values of n—in this case, when n is greater than 100—f will be larger than g. Comparing rates of growth is made easier by looking at a graph, such as the one shown in figure 1. It displays the graphs of several common functions, including those we will be discussing here.

This idea of the size of a function in the long run—the so-called asymptotic rate of growth—is central to the analysis of algorithms. When we compare two algorithms, we usually don't care how well they do on small problems because small problems are easy. We want to know if they can maintain their good performance when the problems start getting large. Sorting a list of 10 items is going to take practically no time regardless of which sorting algorithm we choose. But as the lists get bigger, it becomes clear that the inherently slower algorithms are inferior.

To analyze an algorithm, then, we can derive the function that relates the key operations of the algorithm to the size of the input and obtain its asymptotic rate of growth. But often even this level of abstraction is too detailed. After all, it hardly matters on big problems if a sorting algorithm takes $37n + 4$ comparisons or $24n - 6$. The important point is that the number of comparisons is directly proportional to the size of the input; that is, both functions have an asymptotic growth rate on the order of n. We will rarely go astray in our analysis of algorithms if we ignore additive and multiplicative constants and use order-of-magnitude estimates. In fact,

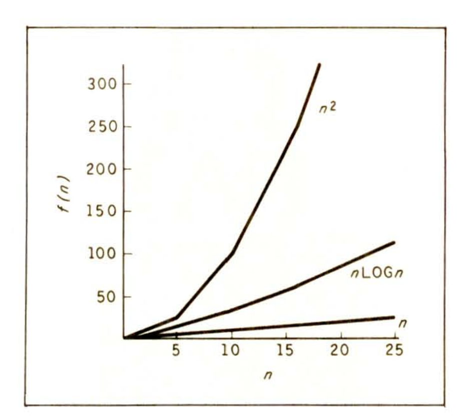


Figure 1: *Rates of growth of some common functions.*

Listing 1: *The algorithm for Selection Sort.*

```
Selection Sort.
Input: an array, A, and its size, n.
Output: the same array A, in sorted
      order.
begin
  for i := 1 to n do begin
    m := i;
    for j := i+1 to n do
      compare A[j] to A[m], making j
      the new m if it is less;
    swap A[i] and A[m];
  end
end.
```

there is a common and convenient notation for this: Write "$f = O(n)$" (or "function f is order n") if the growth rate of f is on the order of n. This so-called "Big O" notation has a more rigorous definition, which goes as follows:

If f and g are two functions, then $f = O(g)$ if and only if there are two constants, c and k, such that $f <= cg + k$.

For example, if f is the function $37n + 4$, then $f = O(n)$, because we can choose c to be 37 and k to be 4, so that $37n + 4$ is equal to $37n + 4$. To take a less obvious example, the function $150n^2 + 97n - 34$ is $O(n^2)$. In this case, we could choose c to be 200 and k to be 13; many other choices are also possible.

Big O notation has several advantages. It eliminates the distracting clutter of constants and slow-growing terms in our functions, making it easier to compare them. It abstracts away from unimportant details, allowing us to study an algorithm in its simplest form. And it simplifies our analysis by freeing us from the tedium of exact counting. To the trained eye, the "Big O" running time of an algorithm is often visible at a glance.

Selection Sort

Let's look at the algorithm for Selection Sort (see listing 1). Given a list of items to sort in ascending order, the idea is to find the smallest item and swap it with the item at the top of the list. Then the next time around we don't have to consider the first item again; instead, we find the minimum of items 2 through n and swap it with the second item. Finding the minimum is done as follows: Start with the minimum set to the first item, go through all the items, and if any one is smaller than the minimum, make it the new minimum.

Let's analyze the algorithm by seeing how many comparisons it performs. The only place we do comparisons is when we find the minimum. We do one comparison for each of the possible values of i and j. When i is 1, j ranges from 2 to n, for a total of $n-1$ values, hence $n-1$ comparisons; when i is 2, j ranges from 3 to n, or $n-2$ comparisons; when i equals $n-1$, j only covers one value; and finally, when i equals n, we don't execute the j loop at all. The total number of comparisons, then, is $(n-1) + (n-2) + (n-3) + \ldots + 1$.

It is not hard to show that this sum equals

$$\frac{n(n-1)}{2} \text{ or } (1/2)(n^2-n)$$

From our discussion of Big O notation, this is $O(n^2)$. So the Selection Sort is an order n^2 sort. That is, for a list of size n, Selection Sort will do on the order of n^2 comparisons. By the way, the famous Bubblesort algorithm is also $O(n^2)$.

Beating n^2: Mergesort

Can we do better than $O(n^2)$? Yes, and the algorithm that does it, Mergesort,

uses the technique of divide-and-conquer to solve a large problem: Divide it into smaller problems of the same type, and solve the smaller problems the same way.

Mergesort takes two sorted lists, A and B, and merges them into a single sorted list, C. We start by comparing the first items of the lists. Since the lists are sorted, the smaller of the first items will be the smallest item overall. Say the first item of list A is smaller. We put this item at the start of C, then compare the next item of A with the first of B. Again, we put the smaller on the C list. We continue in this way until we've gone through both A and B. At the end, C will contain all the items of A and B in sorted order.

Given that we can merge two sorted lists, here's how we sort: If the list to be sorted is longer than one item, we split it in half (or as near as possible) and call Mergesort to sort the two halves. Then we merge the two sorted halves together. Listing 2 shows the algorithm for Mergesort. If the list to be sorted is one item long, then there's nothing to do; it's already sorted.

It is harder to analyze Mergesort than it is to analyze Selection Sort because Mergesort is recursive. First, look at the merge part of the algorithm. It takes at most n comparisons to merge two sorted lists each of size $n/2$ into a single list of size n. To see this, note that every time we do a comparison we add an item to our final list, so we can't do more comparisons than there are items. The merge phase, then, is $O(n)$.

What about the rest of the algorithm? In a sense, there really is no "rest of the algorithm"—the only time any real work (i.e., comparison) gets done is in the merge phase. So the questions are, how often do we merge, and how much do we merge each time?

The best way to view Mergesort is as a binary tree (see figure 2). Each node represents a call on the Mergesort procedure. The top (root) of the tree represents the initial call of the procedure with a list of size n. Mergesort is then called recursively twice, each time with a list of size $n/2$. Each of these invocations of the procedure makes two other recursive calls, until finally we reach lists one item long.

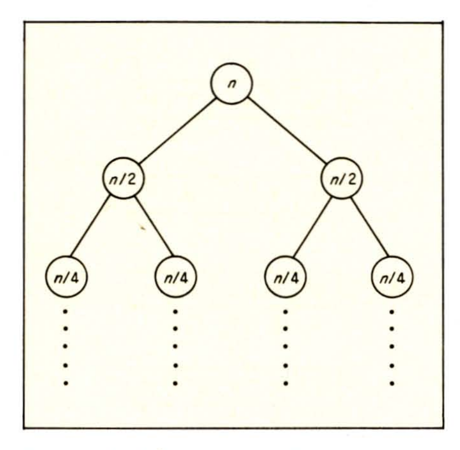


Figure 2: *The Mergesort tree.*

Listing 2: *The algorithm for Mergesort.*

```
Mergesort.
Input: a list, L.
Output: a sorted list, S.
begin
  If L is one item long, then S := L.
  Otherwise,
    split L into two lists L1 and L2,
      each about half as big.
    Mergesort L1 into S1.
    Mergesort L2 into S2.
    merge S1 and S2 into S.
end.
```

At each level of the Mergesort tree, we do $O(n)$ comparisons. At the top level of the tree, the only comparisons occur when we merge two lists of size $n/2$ into a list of size n; this operation takes at most n comparisons. At the next level, there are two merges, each creating a list of size $n/2$. Since each of these merges takes $n/2$ comparisons and there are two of them, we again have n comparisons. At the third level, there are four merges of $n/4$ comparisons each, and the same thing happens for the fourth level of the tree, etc.

We can now state that the running time of Mergesort is $O(nk)$, where k is the number of levels of the Mergesort tree. We can express k in terms of n by noting that the number of levels of the tree is just the number of times you can divide a list of size n in half repeatedly until you get a list of size 1. That's the same as the number of times we can divide the number n by 2 until you reach 1; it happens to be about $\log n$ (by which I mean the logarithm to the base 2 of n). We can convince ourselves of this easily if we choose n to be a power of 2. For instance, 2^2 equals 4; 4 divided by 2 is 2, and 2 divided by 2 is 1.

Armed with this fact, we can conclude that Mergesort is an $O(n\log n)$ algorithm—$\log n$ levels of the tree with n comparisons at each level. That's better than $O(n^2)$, and the larger n is, the better it is. A glance at figure 1 will help you see that the function n^2 grows much faster than $n\log n$. It also helps to look at some numbers: For $n = 8$, n^2 is 64 while $n\log n$ is 24—not much of a difference. But for $n = 256$, n^2 is over 65,000, whereas $n\log n$ is just over 2000.

Again, the obvious question is: Can we do better than Mergesort? If we know beforehand that the values to be sorted are in a limited range—say, the integers between 1 and 100—then it's possible to sort in $O(n)$ time, and furthermore, we never have to compare the items we're sorting. But if we have no special information about the values to be sorted, then we can only use comparisons to sort them. It can be shown that if sorting is done by comparisons only, then $O(n\log n)$ comparisons is the optimum. The proof is beyond the scope of this article, but it is contained in the book *Data Structures and Algorithms* by Aho, Hopcroft, and Ullman (Reading, MA: Addison-Wesley, 1983, page 282). The most thorough treatment of sorting algorithms is contained in Donald E. Knuth's *Art of Computer Programming, Volume 3: Sorting and Searching* (Reading, MA: Addison-Wesley, 1973).

While Mergesort is theoretically as good as possible, if we were to actually implement it, we would discover that it has some hidden costs that slow it down (particularly its need for

(continued)

an extra array in the merge phase). There is an algorithm that, like Mergesort, is O($n$log$n$), but it will nonetheless run faster by a constant factor on all present-day computers. (Remember: 2$n$log$n$ and 1000$n$log$n$ are both O($n$log$n$).) The algorithm, called Quicksort, is the fastest known comparison-based sorting technique.

QUICKSORT

Quicksort works like this: If the list to be sorted has only one item, we do nothing. Otherwise, we pick an item from the list and call it the pivot. Now we partition the list into two halves—items less than or equal to the pivot and items greater than it. Then we sort the two halves. We don't have to do anything after sorting the two halves, since the partitioning has already made sure that all the small things are at the beginning and all the large ones at the end.

Quicksort is similar to Mergesort and, in fact, was inspired by it. The key difference is that instead of a merge phase after the recursive sort, Quicksort has a partitioning phase before the recursion. What makes Quicksort more efficient than Mergesort is that, like Selection Sort, all the work can be done in place; that is, we only have to manipulate the original array. Listing 3 shows the Quicksort algorithm.

We partition an array as follows. We start by pointing to the beginning and end of the list to be partitioned. Say, for example, i points to the beginning and j to the end. Move i forward in the list until we reach an element larger than the pivot. Move j backward until it reaches an element smaller than the pivot. Then swap the item i points to with the one j points to. Repeat this until i meets j and then the list will be partitioned. Figure 3 shows how a list with five items would be partitioned by this method.

The analysis for Quicksort is similar to that for Mergesort. The partitioning phase takes O(n) comparisons, and if the list is partitioned into two almost equal halves, then the Quicksort tree will have log$n$ levels. So Quicksort is O($n$log$n$), right? Well, almost. Our analysis depends on the fact that the list will be split nearly in half. That, in turn, depends on how we choose the pivot. Say we always choose the first element as the pivot. Now, if we assume a random distribution of lists, then on the average the first item will be somewhere comfortably between the largest and the smallest, so the list will be partitioned nearly in half. So, on the average, Quicksort is O($n$log$n$).

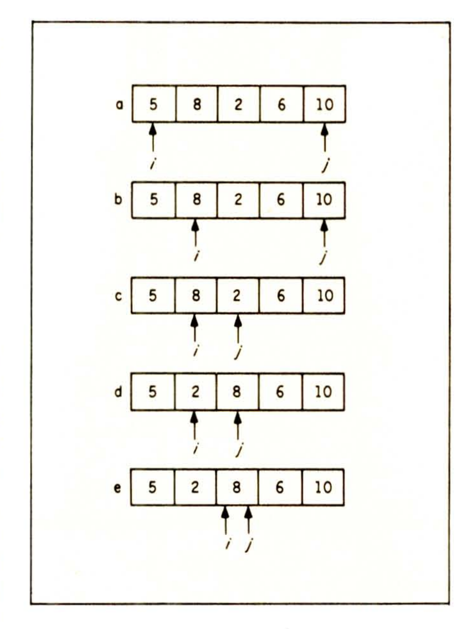


Figure 3: *Partitioning of an array segment in Quicksort. In line a, i and j point to the beginning and end of the array, respectively. The pivot is taken to be the first element, here 5. In line b, i moves forward until the element it points to is greater than the pivot. In line c, j then moves down until it reaches an element less than or equal to the pivot. In line d, the two elements pointed to by i and j are swapped. And in line e, i then moves up again, becoming equal to j. This terminates the partitioning phase.*

Listing 3: *The algorithm for Quicksort.*

```
Quicksort.
Input: an array A, with items from
  1 to n.
Output: the same array, sorted.
begin
  choose a pivot;
    partition the list so that all
        items <= pivot are < i;
    Quicksort A from 1 to i-1;
    Quicksort A from i to n;
end.
```

But let's look at the worst case: Say we always manage to choose for our pivot the largest (or smallest) item in the list. Then we will partition the list into two parts, one of size 1 and the other of size $n-1$. We would then partition the second of those into lists of size 1 and $n-2$, etc.—a total of n partitions that take times $n-1$, $n-2$, and so on. The analysis looks similar to that for Selection Sort, and indeed the result is the same. So the worst-case time for Quicksort is O(n^2).

It should be clear now that the choice of pivot is very important. If we choose it wisely, we can decrease our chances of ending up with a slow sort. There are lots of ways to choose pivots cleverly. For instance, we might choose three items at random and use the median (middle item) of the three as the pivot. This would improve Quicksort's chances of running in O($n$log$n$) time without slowing it down too much. However, in my implementation, I simply choose the first element as a pivot every time. This strategy will give worst-case behavior when the list is in either sorted or reverse-sorted order, so if you expect to be sorting a lot of nearly sorted lists, you should choose your pivot more cleverly.

There is another problem with Quicksort that has to do with the amount of space it takes. We haven't considered space utilization until now, but it can be important. Selection Sort uses a small amount of space and, more importantly, the space it uses is independent of the size of the array. But because Quicksort is recursive, every time the procedure is invoked, some information is placed on the

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run-time stack. In the worst case, Quicksort can call itself recursively *n* times, so the stack will take up O(*n*) space. There is a clever way around the problem that will guarantee that the program uses no more than O(log*n*) stack space. The trick involves making the first recursive call on the smaller of the two partitions and eliminating the second recursive call altogether by incorporating it into a loop. It's a bit messy and probably not worth it unless you're really worried about the space.

Some Real Data

While the order-of-magnitude estimates of running times are useful, it's often nice to have some real data as well. With that in mind, I ran Selection Sort and Quicksort on integer arrays of various sizes with items chosen randomly. The results are shown in table 1. As you can see, the difference on small lists is negligible, but on large lists it becomes enormous. The programs I used were written in MacPascal on a Macintosh computer. (They are available for downloading via BYTEnet Listings at (617) 861-9774.)

Sorting Big

Both Selection Sort and Quicksort suffer from a serious flaw. They both work best as internal sorts. That is, in both cases we assumed that we could fit the entire list of items to be sorted into an array, which presumably would be held in RAM (random-access read/write memory), and that the time required to examine and change elements of an array is small, which indeed it is if the array is entirely in main memory. But what do we do when you have to sort so many items they cannot all fit into memory at once?

We need an algorithm to handle this external sorting problem. For example, say we have a file of a million records on disk. Now, we could treat this file as an array and run Quicksort much as it is, but we would have an incredibly slow algorithm. The reason is that accessing information from a disk is slower than accessing main memory. What we would like to do is to take advantage of the fact that reading a lot of information from a disk takes almost the same amount of time as reading a little, if the information is stored consecutively on the disk. That's because most of our time is spent finding the information on the disk, and only a small fraction of time is spent actually reading it. The same goes for writing. All operating systems use this fact; when asked to read a byte from the disk, they read in a block of bytes containing the one byte desired. Then if the next byte requested is within the block that was just read in, it will already be in memory and a disk access can be saved. When asked to write a byte to the disk, the operating system uses the same trick.

We want an algorithm that exploits these facts about disks. The problem with Quicksort is that it swaps items that are distant from each other in memory, so it doesn't exploit the sequential organization of disk memory. Mergesort, however, reads and writes the files in order, thus taking advantage of the disk buffering done by the operating system. Recall that the merge phase expects two sorted lists

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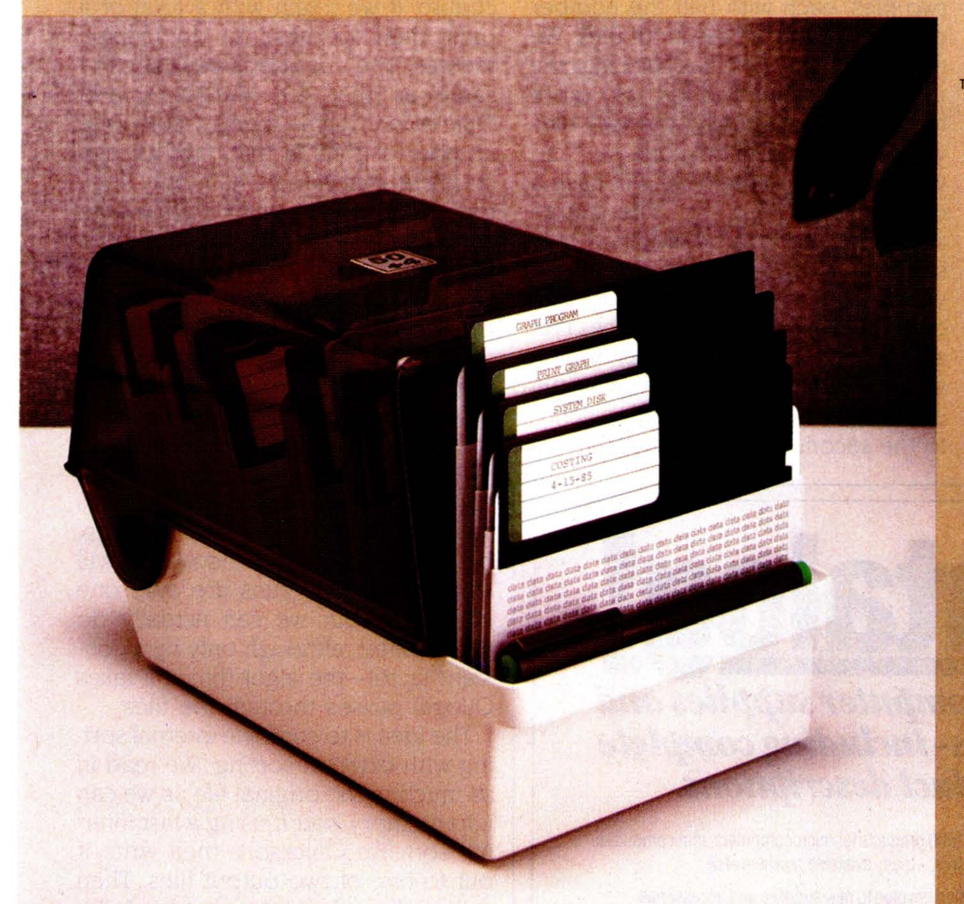
Table 1: A *comparison of running times (given as minutes:seconds) of Selection Sort and Quicksort.*

List Size	Selection Sort	Quicksort
10	<0:01	<0:01
50	0:05	0:05
100	0:20	0:09
500	7:49	1:02
1000	31:01	2:10



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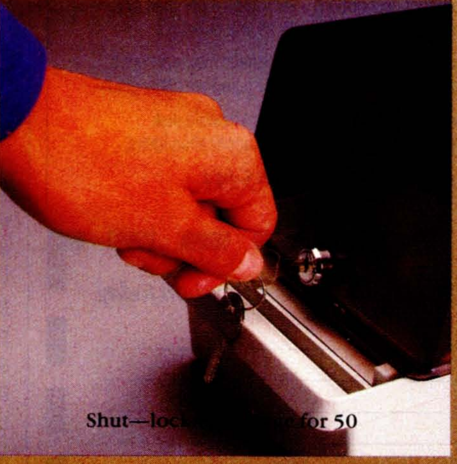
Elementary, my dear Watson.

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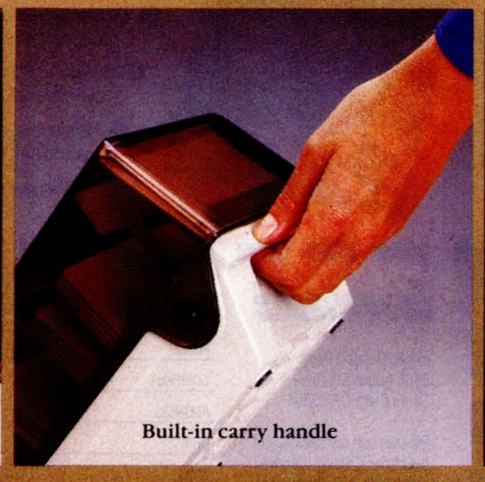




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Mergesort reads and writes the files in order, thus taking advantage of the disk buffering done by the operating system.

and produces another list. It does this by scanning the two sorted lists in order, choosing the smallest item each time. If the lists are files, then we have a good way to merge two sorted files into a larger sorted file. We will need to modify the merging algorithm slightly for our purposes, though. Instead of taking two sorted files, it will take two files, each of which contains some number of sorted runs of items. For instance, one file might contain the items 1, 3, 4, 2, 6, 5, 6, 8, 9. While the whole file isn't sorted, it does consist of three groups of items, each of which is sorted: 1, 3, 4; 2, 6; and 5, 6, 8, 9. The merge phase will output two files, each with half the number of runs of either of the input files. We then feed these two files back into the merge algorithm and get two more files again. Eventually, the two files will each consist of only one run, and when we merge them we will have a completely sorted file. The merge algorithm needs to be modified only slightly to accommodate these changes. It merges items onto one output file as usual until it notices that an item is not in sorted order, then it writes the remainder of the other run onto the first output file and switches to the second one. (The program for sorting a file with Mergesort [written in MacPascal] is included in the listings that can be downloaded from BYTEnet Listings.)

In analyzing the merging, we want to consider the number of times we have to read through the files, since that is the bottleneck of the procedure. If we begin with a total of n runs, then we have to do $O(\log n)$ merges. The analysis is basically the same as that for Mergesort and Quicksort: Each merge cuts the number of runs in half, and we can divide a number in half only $\log n$ times before we get to 1. Each merge reads the files once, therefore the total number of file passes is $O(\log n)$. Since a single merge takes $O(n)$ comparisons, the algorithm is, like our internal version of Mergesort, $O(n \log n)$.

Only one problem remains: How do we get the files into lists of sorted runs in the first place? Actually, we don't have to. We could just take the original file, split it in half, and start merging, because the merge algorithm will work even if the runs are only one item long. But we can actually do much better, although only by a constant factor—the algorithm still takes $O(\log n)$ passes through the files.

The idea is to combine internal sorting with external sorting. We read in as much of the original file as we can into memory, sort it using a fast internal sort like Quicksort, then write it out to one of two output files. Then we read in the next chunk of the original file, sort it, and write it to the other output file. We continue in this way until we've gone through the entire file. Now we're left with two files of sorted runs, ripe for merging.

Even though this is only a constant factor better than the straight merge algorithm, the constant is enormous—all of memory. For example, say we have a million-item file to sort. The merge algorithm alone would take 20 passes in the worst case, but if we can sort 10,000 items at a time in memory, then in one pass we can break the file up into 100 runs, which we can merge together into a single sorted file in another seven passes. ■

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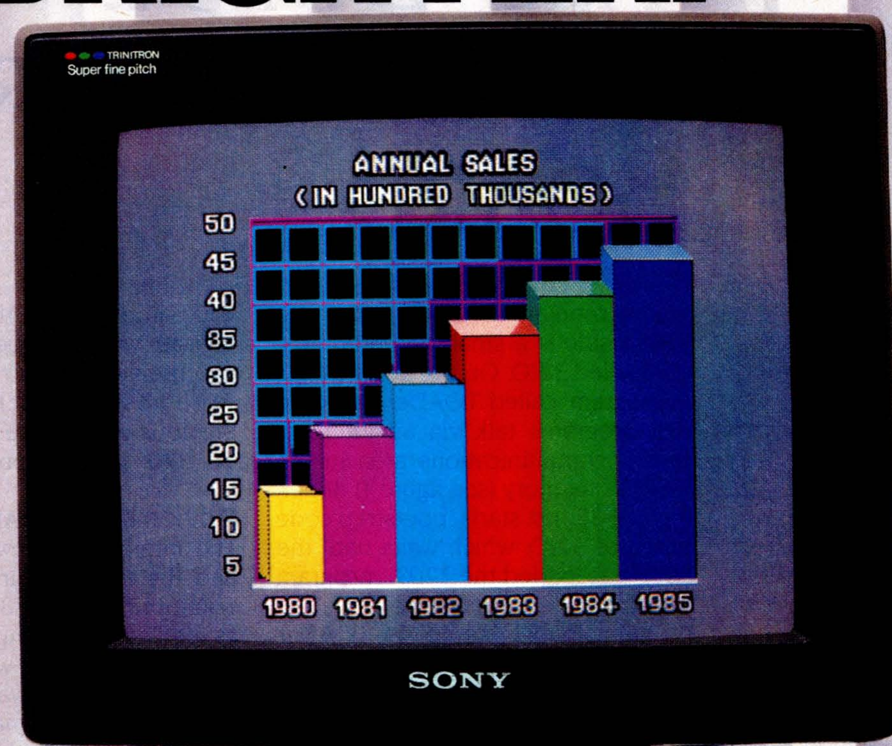
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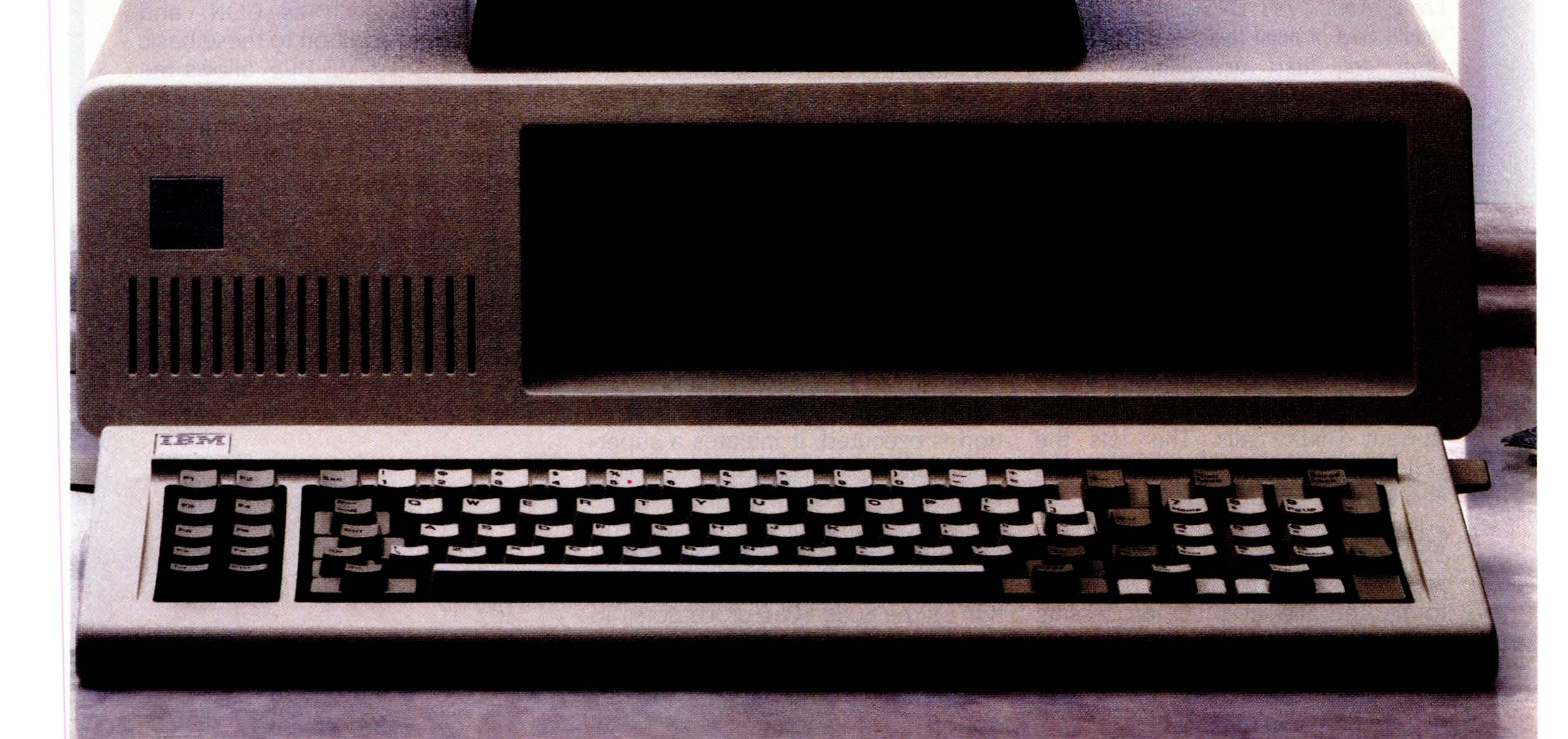
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THE DSI-32 COPROCESSOR BOARD

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Editor's note: This is part 2 of a two-part series describing Definicon Systems Inc.'s DSI-32 32032 *coprocessor board for the* IBM Personal Computer (PC). *Part 1 included a description of the hardware, and part 2 will focus on the software available for the board. If you are interested in a closer look at* National Semiconductor's 32000 *series, refer to* "The National Semiconductor NS16000 *Microprocessor Family" by* Glenn Leedy, April 1983 BYTE, *page* 53. *You should keep in mind that the* 32000-*series chips are direct descendants of the* 16000-*series chips, and that the design philosophies and internal operation of both families are identical.*

Definicon has developed an unusual software interface for the DSI-32. The traditional software environment for a 32-bit computer has been some version of UNIX; instead, Definicon opted for a "shell" program and compilers that emulated the important UNIX calls. This lets the DSI-32 run both UNIX applications and existing MS-DOS applications. An additional advantage is that the 32032 I/O (input/output) operations are off-loaded to the 8088, which performs the file and I/O processing concurrently.

This interface consists of two programs running in tandem. On the 32032 side is a small operating system called 32IO. On the 8088 side is a program called LOADer, and the two programs talk via an interprocessor communications area in the DSI-32's memory (see figure 1). When the DSI-32 first starts, bootstrap code executes 32IO, which waits until the 8088 has loaded the 32032 program into the DSI-32's memory. Once the program load is complete, LOADer tells 32IO to execute the loaded program. Thereafter, if the 32032 program needs to open a file, write a character to the screen, or perform any other I/O operation, it passes that request to 32IO, which in turn passes it to the 8088.

The software interface uses the features of both the 8088 and 32032 environments. LOADer, written in C, runs under MS-DOS (or Concurrent PC DOS). Since it manages most of the file I/O, it is relatively complex (about 35K bytes of code). The 32IO module handles most of the computationally intensive tasks. Together they form the interface detailed in table 1.

A program running on the DSI-32 makes I/O requests to the 32IO program via the 32032's SVC (supervisor call) instruction. When an SVC instruction is executed, it initiates a supervisor call trap. This causes the 32032 to vector to a known location; it acts like a shorthand subroutine call. (The SVC instruction is directly analogous to the INT software interrupt instruction on the 8088/8086 processors.) To execute any of the 32IO program's service requests (as shown in table 1), you simply load the 32032's R0 register with a request number and execute an SVC instruction. (See the April 1983 article mentioned previously for more information on the 32032's components.)

DEVICE DRIVERS AND HANDLES

The interaction between the 32032 and the 8088 occurs at two levels. Some primitive 8088 functions, such as reading and writing blocks of memory or reading and writing I/O ports, have been made available to 32032 programs, but the majority of the interface uses the MS-DOS device-driver concept.

Most users are familiar with MS-DOS devices such as CON: and COM1:, but in addition to these basic system facilities, MS-DOS allows the installation of special device drivers, such as .SYS files, at boot time. For example, if a GPIB (general-purpose interface bus) card has been installed in this way, a user program could define a driver for a device called GPIB:, open it in the same way as opening any other file, and access the GPIB card without any need to know about special memory locations, I/O ports, or other system-dependent parameters. UNIX goes a step further,

treating even CON: as the standard input device, which is labeled <STDIN>, so that all computer interfaces are accessed through the common file system. The Definicon MS-DOS interface has been designed to be similar to UNIX in this respect. The supervisor request to open a file (see request 5, table 1) opens the device whose name has been passed to it and returns a "handle," which is a 16-bit number assigned by the MS-DOS operating system to every file or device that a program has opened. Subsequently, when the program performs an I/O operation, the program informs the operating system where that I/O is to occur by passing it a handle. Detailed descriptions of handles can be found in most technical reference manuals for MS-DOS version 2.xx or higher.

Some handles are predefined and you need not explicitly open them to use them. For example, the handle for <STDIN>, which is usually the keyboard, is 0. The handle for the standard output device, <STDOUT>, usually the CRT (cathode-ray tube), is 1, and the standard error device, <STDERR>, is 2. You may redirect all these channels if you desire.

Thus, to write a character to the CRT using the interface, you would write in C

```
putc(char)
```

or in assembly language

(continued)

Trevor G. Marshall, George Scolaro, David L. Rand, and Tom King are engineers with Definicon Systems Inc. Vincent P. Williams is president of Definicon. They can be contacted at 21042 Vintage St., Chatsworth, CA 91311.

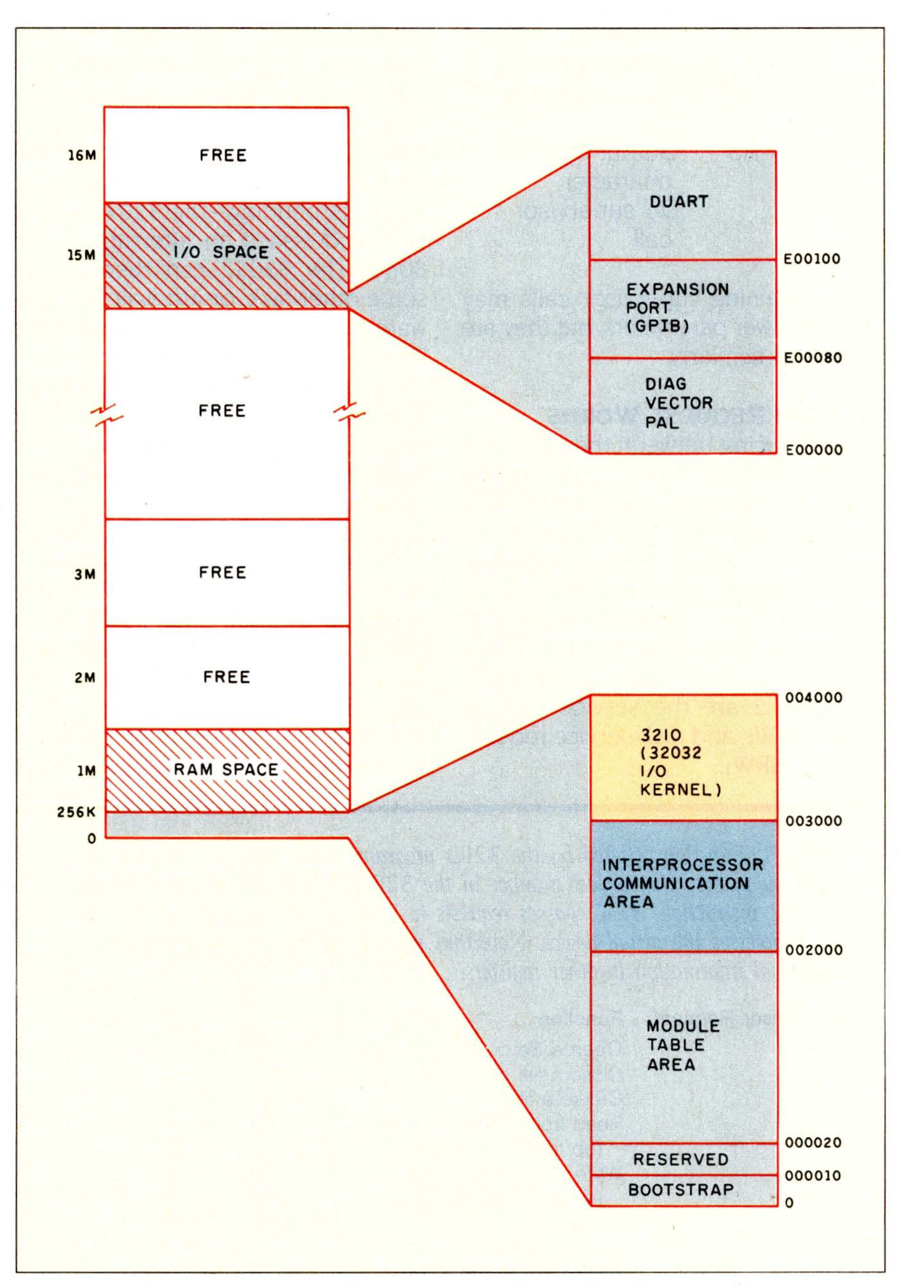


Figure 1: *The DSI-32's memory map. 3210 is the I/O kernel that resides between locations 3000 and 4000. All addresses are in hexadecimal.*

```
MOVB  9,R0     ;Supervisor request
                9, write to device
MOVW  1,R1     ;Handle of
                <STDOUT> is 1
ADDR  char,R2  ;Point at char to
                "put"
MOVW  1,R3     ;Output only 1
                character
SVC            ;Do supervisor
                call
```

The remaining supervisor calls may require fewer parameters, but they are accessed similarly.

SERVICE REQUEST WORDS

All interfacing between the 8088 and 32032 takes place in the first page of memory, or physical address 002000 through 0F2000 (hexadecimal) as seen by the 32032. [*Editor's note: All addresses appear in hexadecimal unless specified otherwise.*] Figure 2 lists the significant locations within that memory area. Two important communications areas in figure 2 are the service request word (SRW), and disk service request word (DSRW).

There is a 32032 SRW and an 8088 SRW. As shown in figure 3, these words act as mailboxes, holding messages that the two processors send to one another. For example, when the 32032 wants input from the keyboard, it first checks the 8088 SRW. If the SRW is clear—meaning no action is pending—the 32032 sets it to 1 and issues an interrupt to the 8088. The 32032 can then go do some other task, or just wait in a software loop for the 8088 to service the keyboard-input request.

The 8088, upon getting the 32032's interrupt, checks its own SRW and discovers that it has been set to 1. The 8088 then places the next character typed at the keyboard into the keyboard queue, sets the 32032 SRW to 1, clears its own SRW, and sends an interrupt back to the 32032. When the 32032 processes this interrupt, it clears the 32032 SRW, fetches the character from the keyboard queue, and continues with the main program. (Normally, the 8088 puts all characters in the keyboard queue anyway, even if the 32032 does not specifically ask for them.)

There is only one DSRW, and it is a little more complicated than the SRWs (see figure 4). Basically, it holds a code number corresponding to the particular I/O operation that the 32032 needs the 8088 to perform on a handle, which typically corresponds to a disk file.

Table 1: *Functions offered by the 32IO program. Each supervisor request is called by placing the request number in the 32032's R0 register and executing an SVC instruction. 32IO passes requests to LOADer (running on the 8088), which accesses the actual device. Note that many supervisor requests require additional information in other registers.*

Supervisor Request	Function
5	Open a file or device for I/O
6	Close a file or device
7	Create a file
8	Read from a file or device (up to 65536 bytes)
9	Write to a file or device (up to 65536 bytes)
10	Erase a file
11	Rename a file
12	Seek to a byte in a file (The offset to seek to can be from beginning of file, current position in file, or end of file.)
13	Return current position in file
14	Get command-line arguments
15	Terminate 32032 execution
16	Move data from IBM to DSI-32 (up to 65536 bytes)
17	Move data from DSI-32 to IBM (up to 65536 bytes)
18	Input from port on IBM
19	Output to port on IBM
20	Execute a software interrupt on the IBM

SUPPORT FOR IBM BIT-MAPPED GRAPHICS

System call 17 (see table 1) moves memory from the 32032 to the IBM. This allows you to set up single or multiple 16K-byte graphics screen images in the 32032's memory space and swap them into the IBM PC's screen memory. It takes only a few tens of milliseconds to totally replace a PC's screen in this way. Thus, an application that, for example, requires animation, can use the 32032 to set up successive backgrounds in its own memory space, swapping only those portions of the screen memory actually necessary to update the foreground motion. When a background change is needed, it can be transferred to the display in a fraction of a second. Note that it would be possible to set up a large background space from which the 16K-byte screen display could be "zoomed," using the 32-bit integer manipulation capability of the 32032. Applications that have already been written (in a high-level language) can perform bit-mapped graphics with nearly identical code in the DSI-32 environment.

HIGH-LEVEL LANGUAGE COMPILERS

Early in the DSI-32 design, Definicon benchmarked a variety of hardware/software combinations. These benchmarks revealed huge speed variations that could only be attributed to compiler efficiency. For example, there was a large speed difference between the various implementations of the UNIX portable compilers, a difference that seemed to depend on the porting efficiency that the particular company was able to achieve.

(continued)

32032-8088 Interface

Memory	Contents	
2000	Service request word (SRW) indicates what 8088 wants	
2002	8088 completion status	
2004	Request word indicates what 32032 wants	
2006	32032 completion status	
2008	8088 queue pointer (->2050)	Keyboard queue
200A	32032 queue pointer (->2050)	
200C	8088 queue pointer	Video queue
200E	32032 queue pointer	
2010	8088 queue pointer	Printer queue
2012	32032 queue pointer	
2014	Disk service request word (DSRW)	
2016	Current handle	
2018	Number of bytes to transfer	
201A	DWORD (double word) pointer to DTA (disk transfer area)	
201E	Disk completion status	
2020	Heap low address	
2024	Heap high address	
2028	Stack low address	
202C	Stack high address	
2030. . .	Reserved for expansion	
204F	Reserved for expansion (32 bytes)	
2050	64-byte keyboard buffer	
2090	2048-byte video buffer	
2890	1024-byte printer buffer	
2C90. . .	Reserved for expansion	
2FFF	Reserved for expansion (880 bytes)	
3000	Start of free memory	

Figure 2: *Memory on the DSI-32 can be accessed by either the on-board 32032 or the PC's 8088, and the two processors use the memory for communication with one another. Some of the more important locations used are shown above.*

Service Request Word (SRW) Definitions

SRW	Action
1	Keyboard input
2	Video output
3	Printer output
4	Disk operation requested
5	Argument request (get command-line values)
7	Task completed normally
FFFF	Abnormal task completion, see completion byte for details

Figure 3: *Possible values for the service request word and their meanings. Each value corresponds to a specific request made by one processor to the other.*

THE 32000 AND HIGH-LEVEL LANGUAGES

The NS32000 instruction set eases the task of writing efficient compilers. As an example, let's look at a simple subroutine in C that normalizes the size of a positive floating-point number to be between 0.5 and 1 and returns the corresponding scaling exponent such that

input argument = normalized result * 2ˆexponent

This subroutine, in C, might be written as shown in listing A.

A more efficient means of performing this function is to examine the way in which the IEEE (Institute of Electrical and Electronics Engineers) standard specifies a floating-point number (see figure A). The number is made up of a sign bit, an 11-bit exponent, and a 52-bit mantissa. We can write figure A as a structure in C (using bit fields):

```
typedef struct {
        unsigned mantissa 1  : 32 ;
        unsigned mantissa 2  : 20 ;
        unsigned exponent    : 11 ;
        unsigned sign        : 1 ;
} double__precision__ieee;
```

When the Normalize subroutine is called, this number will have been pushed onto the stack by the calling routine. All the Green Hills compilers use identical calling procedures, so the code and subroutines from each can be intermixed. Using this new structure, we could rewrite the subroutine as shown in listing B.

The Green Hills C compiler generated the 32032 machine code in listing C.

We leave it to you to check the assembler code your favorite compiler generates with this routine. With our 8088 and Digital Research C, this source code generated about 22 lines of assembler, plus a call to a library function.

Listing A: *A sample C program to normalize a floating-point number to between 0.5 and 1.*

```
double normalize(y,exp)
double y;
int *exp;
int scaler = 0;
{
if ( y > 1.0)
    while(y>1.0) {scaler=scaler+1; y=y/2.0; }
else if (y<0.5)
    while (y<0.5) {scaler=scaler-1; y=y*2.0; }
*exp=scaler;
return(y);
}
```

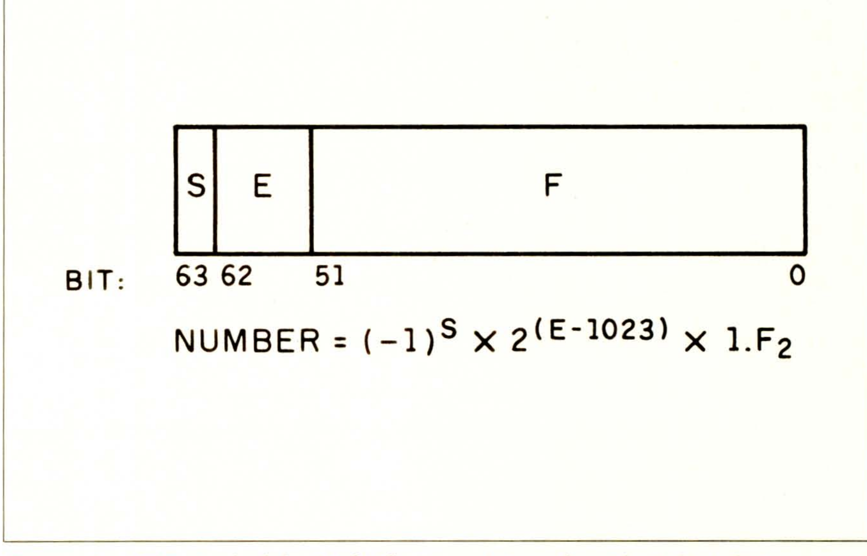


Figure A: *IEEE standard for 64-bit floating-point number. The S bit indicates the number's sign—0 is positive and 1 is negative. The E or exponent field is in excess—1023 form (subtract 1023 from the value in the E field to get the actual exponent). The F field holds the fractional portion of the number.*

Listing B: *A modified version of listing* A, *using a* C *data structure.*

```
double normalize(y,exp)
double y;
int *exp;
{
    /* create a pointer to the argument passed on the stack */
      register double__precision__ieee *pointer = &y ;

    /* calculate an exponent value by subtracting 1023 (all */
    /* ones) from the argument's exponent value */
      *exp = pointer -> exponent - 1023;

    /* and normalize the argument's exponent to all ones */
      pointer -> exponent = 1023;
    /* return the modified number (and of course, the exponent)*/
    return(y);
}
```

Listing C: 32032 *machine code generated by the Green Hills C compiler for the program shown in listing* B.

```
.module normalize.c
.program
__normalize: -
        addrd   8(sp),r1         ;first line of C code done
        extsd   6(r1),r0,4,11    ;EXTract Short Double
                                 ;from bit one, length of 11
                                 ;from the 32-bit word at (R1)+6
                                 ;put them into bits 0-10 of R0
        subd    1023,r0          ;next line of C code
        movd    r0,0(16,sp))     ;put it onto the stack for return
        inssd   1023,6(r1),4,11  ;INSert Short Double
                                 ;syntax similar to above extsd
                                 ;except that an immediate field
                                 ;inserted
        movl    8(sp),f0         ;get Y to F0, the return code
                                 ;for the calling program
        rxp     0
;__pointer r1   local            ;the compiler tells us where
;__y 8(sp)      local            ;it put the variables
;__exp 6(sp)    local
.endseg
```

To better evaluate compiler efficiency, Definicon examined the intermediate assembler source-code outputs and was able to divide the differences into the following two categories:

- degradations in floating-point performance due to a compiler's inability to produce in-line source code
- degradations due to the inability of the compiler to optimize its output code

Lack of in-line code often leads to a call to a subroutine every time a mathematical operation is performed. With in-line code, the compiler produces code to perform a mathematical operation—such as multiplication—every time it scans the operation. With the compact instruction set of the 32000 series, this reduces several lines of code to just one or two.

Lack of optimization is easily recognized. For instance, when compiling a benchmark that Definicon had devised to test floating-point operations, the UNIX portable C compiler produced the following code within the $Z = Y * X$ execution loop:

```
MOVF __X,F0   ;get X from memory
                to floating register
                0
MULF __Y,F0   ;multiply it by Y
MOVF F0,__Z   ;store the result in
                Z (in memory)
```

The Green Hills compilers shifted X and Y into floating-point registers outside the loop and then performed the much faster

```
MULF F0,F2    ;multiply where it
                stored X and Y
MOVF F2,F4    ;and store it where
                it wants Z
```

(It was interesting to note that the VAX compiler optimizers were so efficient that they removed any operations that produced results that were not used later in the program. This caused a great deal of trouble until Definicon devised benchmarks to force the generation of real code.)

Several other differences between

(continued)

compilers were also evident. The 32032 has a "move quick" instruction for immediate operators in the range of +8 to −7. For example:

MOVQD 6,R0

is only a 2-byte instruction that moves 6 into register R0 as a 32-bit ("double") quantity. If the operand is out of this range, most other compilers generate:

MOVD 34,R0,

which takes longer to execute than the previous instruction because the 34 is stored as a 32-bit, immediate double word.

The Green Hills compilers, however, generate

ADDR @34,R0,

which tells the CPU (central-processing unit) to calculate the effective address of 34, which is of course 34, and place the resulting 32 bits in R0. This construct requires only a 1-byte field for the immediate value and therefore executes faster.

Consequently, Definicon selected the Green Hills C, Pascal, and FORTRAN compilers for the DSI-32. Since these compilers were written in Pascal, Definicon attempted to port them by compiling them in an 8088 Pascal. This did not work because of segmentation constraints on the 8088 (see the text box "The Need for Speed" on page 124), so Definicon wrote an interface package that was used to port the Pascal compiler to the DSI-32. When Pascal was running successfully on the board, it was used to bring up the C and FORTRAN compilers.

FORTH

FORTH-83 defines integers and addresses clearly as 16-bit words. This severely limits FORTH's usefulness in a full 32-bit environment. Because each memory access on the DSI-32 (including, of course, stack accesses) is 32 bits wide, it makes no sense for a 32032 FORTH implementation to observe these restrictions.

(continued)

Disk Service Request Word (DSRW) Definitions

DSRW	Action
1	Open a file, returning a handle of 1-0xFFFF, or 0 if not found. The filename desired will be in the DTA, with the number of bytes count set to the length of the filename. Note that the DTA is a DWORD pointer, and thus the DTA may be anywhere in the 32032 address space.
2	Make a file, returning a handle of 1-0xFFF, or 0 if the disk system is full. Same notes as 1, except that if the file exists, it is truncated to a length of zero.
3	Close a handle, returning the filename in the DTA, with the number of bytes count set to the length of the filename. If an error occurs, then a completion status will be nonzero.
4	Rename a handle. The new name is in the DTA, with length set as above. An error is shown by a nonzero completion status.
5	Read data from a handle. Data is read into the DTA, for a count of *n* bytes. Errors are returned as nonzero completion status.
6	Write data to a handle. Data is written from the DTA, for *n* bytes count. Errors are returned as nonzero completion status.
7	Seek to location. The current handle file pointer is moved to the location specified by the value in the DWORD DTA pointer. This allows 2^31 file size.
8	Tell current location. The current handle's file pointer location is returned in the DTA pointer.
9	Delete a file. The DTA points to a valid filename. Status is returned in the handle.

Figure 4: *Values for the disk service request word and their meanings.*

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THE NEED FOR SPEED

Early in 1984, Definicon Systems Inc. developed an advanced algorithm for spectral decomposition and performed most of the development work on a VAX-11/780. When that became too expensive, Definicon turned to an HP9000 32-bit supermicrocomputer. After a few months Definicon realized that owning an IBM PC clone would be much cheaper than leasing the HP9000.

Before deciding to go with the IBM PC architecture, Definicon performed benchmarks on a range of machines, from the VAX minicomputer, through 68000 UNIX-based machines, to PCs. The benchmark programs included the prime-number sieve, as well as a program devised specifically to test the arithmetic processing unit's speed. The early results indicated than an IBM PC clone was capable of providing about the same performance as the more expensive machines. So Definicon bought an Eagle Turbo, which had about twice the measured speed of a basic IBM PC XT.

When Definicon converted the algorithms to Microsoft FORTRAN, they were unpleasantly surprised to find that the benchmarking had been misleading. The algorithms took about 90 minutes to run on the 8086—about 5 times longer than the benchmarks had indicated. It took Definicon several months to find the problem.

The prime-number benchmark—the popular "Sieve of Eratosthenes" (see "Eratosthenes Revisited: Once More through the Sieve" by Jim Gilbreath and Gary Gilbreath, January 1983 BYTE, page 283)—initializes a Boolean (byte) array to logical TRUE then blanks out the nonprime numbers one by one, leaving only the primes unmarked.

For several reasons, the Sieve of Eratosthenes turns out to be a particularly bad indicator of advanced processor performance. For one thing, the usual array size is 8191 numbers, a value that exercises only the 16-bit arithmetic capabilities of the CPU. In addition, the array is Boolean, a byte array that means the 32-bit processors usually discard 3 of the 4 bytes they fetch at each memory access.

The true measure of CPU performance, however, can be glimpsed when the array grows. When we try to find the primes in the first 40,000 numbers, for instance, a different picture emerges. The IBM PC AT (and the XT) drops to about 1/8 the performance of the 32- and 64-bit machines when 32-bit arithmetic has to be used (numbers are larger than 32,767).

A fundamental limit of the segmented architecture (found in the 8088/8086/80286 CPUs of the IBM PCs) is reached when the array extends to 65,536 numbers. Definicon could not find a compiler for the 8088/8086 that could deal with arrays with more than 2^{16} elements.

Another major limitation of the segmented architecture, however, is not shown by the Sieve. The 8088/8086 and 80286 have a data space that only spans 64K bytes at a time. To handle data structures larger than 64K bytes, these CPUs must employ lengthy tests whenever a data byte is fetched. These tests check to see if the byte is from the current data segment and, if not, must switch the processor to the needed segment.

Although Definicon was interested primarily in scientific applications, the performance conclusions generally apply to many business software applications. In particular, spreadsheets and database managers are slowed considerably by the 64K segmentation overhead.

The 32032 architecture avoids the segmentation delays. Every module of code written for the 32032 has a module table. Each module table has four entries: static base, link table base, code base, and one reserved entry. The 32032 supports a "call external procedure" mechanism that uses the module table for a fast context change. A routine may also access an external variable if it knows both the module in which the variable is declared and the offset (to the variable location) at which the required data is stored.

A 32032 FORTH is available for the DSI-32 board from Symbolic Processing Systems of Orange, California. Symbolic Processing Systems' FORTH defines all integers and addresses as 32 bits wide. In addition, the storage order of bytes in memory has been changed to match that of the 32032. [*Editor's note: The 32032 stores all multibyte quantities with the least significant byte at the lowest address.*] This version includes the FORTH editor, string and file support, together with all floating-point operations.

Serious FORTH programmers will be interested in the upgraded FORTH package, complete with an assembler, debugging aids, the metacompiler, and FORTH source screens. The metacompiler allows recreation of a customized FORTH from its source screens. The debugging tools, including TRACE and VIEW facilities and a decompiler, provide a full-featured 32-bit FORTH programming environment. In addition, this FORTH is multitasking, with the number of tasks limited only by the available memory space. (See the text box on page 134 of the August BYTE for price information.)

Additionally, a small LISP interpreter and a small BASIC compiler, both written in FORTH, are available for the DSI-32.

CONCLUSION

Coupled with the UNIX-like shell and high-level language compilers, the DSI-32 board performs on a level previously occupied by expensive minicomputers. It offers IBM PC owners 32-bit computing—an upgrade that doesn't cause the usual problem of equipment obsolescence.

A FORTH interpreter is available for $299 from Symbolic Processing Systems, 501 West Maple, Orange, CA 92668, (714) 637-4298. ■

ACKNOWLEDGMENTS

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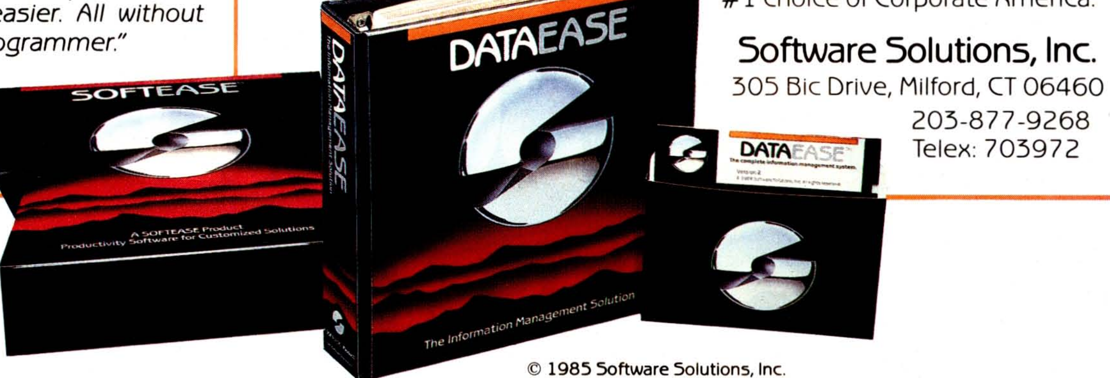
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Inquiry 341

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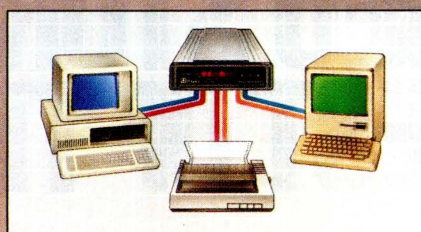
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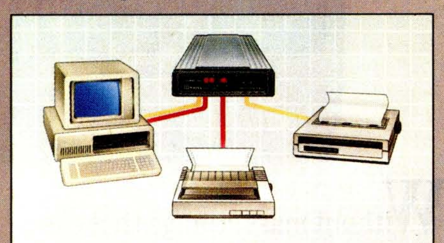
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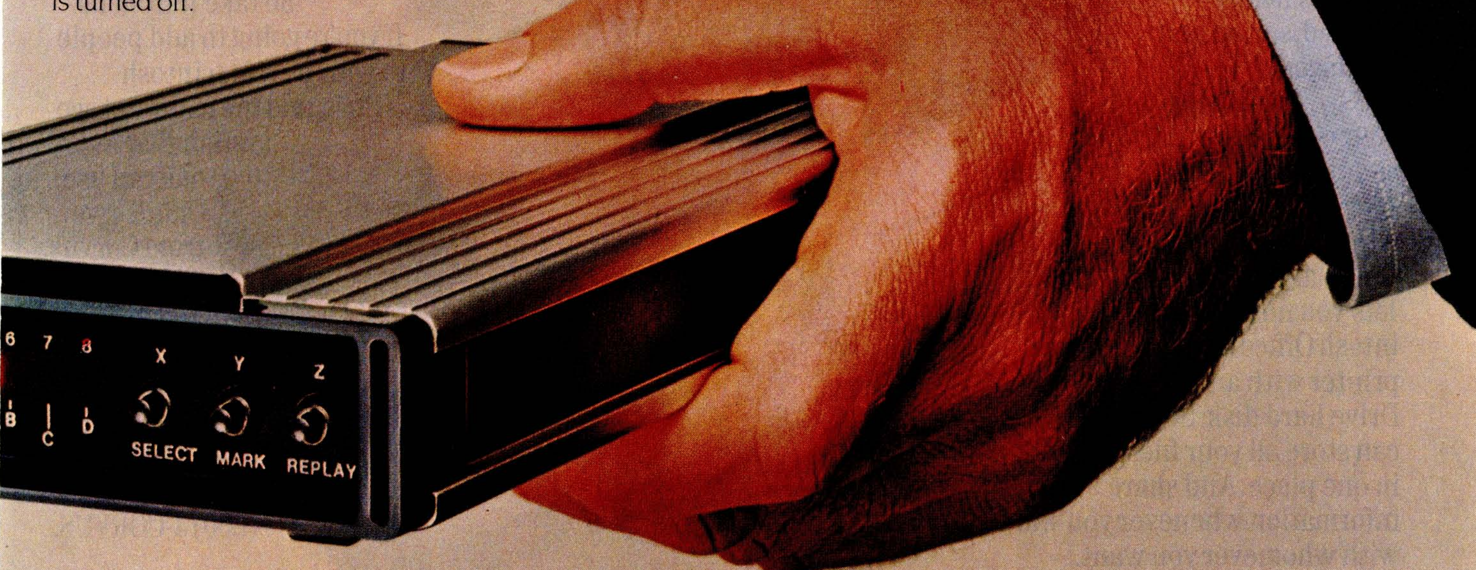
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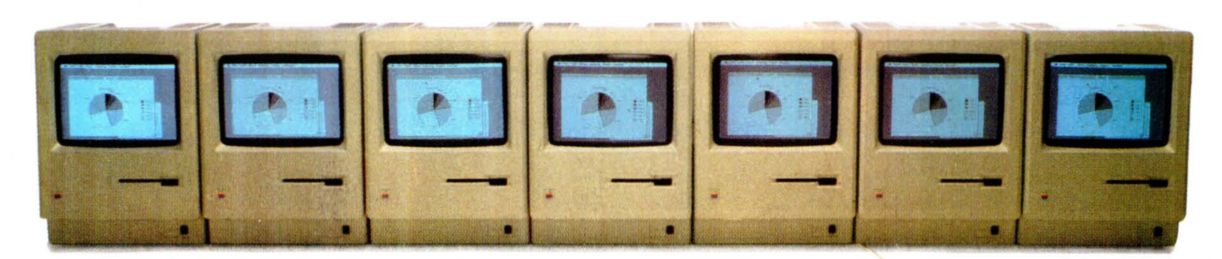


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Inquiry 166

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Inquiry 93

BY BRIAN MCKEON

AN ALGORITHM FOR DISK CACHING WITH LIMITED MEMORY

Efficient disk buffering for a small system

Reading and writing to floppy disks is often time-consuming on microcomputers. The increased use of 16-bit microprocessors has caused floppy-disk delays to become a significant bottleneck in many programs for these processors. One solution to this problem is to add a RAM (random-access read/write memory) disk, but this is an expensive answer. This article presents a set of C functions that use a small amount of memory to store (cache) copies of certain disk sectors and improve the performance of floppy-disk systems. The algorithms used in these functions are suitable for any situation in which only a small amount of memory can be allocated as a cache.

The routines were developed as part of a multiprocessing operating system, now dubbed "Tonto," for the 8088/86 processor (see listing 1). The goal was to have multiprocessing and UNIX-like behavior on a system with floppy-disk drives and 128K bytes of memory. Originally I added caching to read or alter single bytes in a disk block (sector) without having to be concerned with reading and writing the whole block. Later, I improved the performance of the operating system significantly by the caching algorithm that I will describe in this article.

Disk-block caching is a technique whereby copies of a number of disk blocks are kept in memory. If any requests are made to read from or alter the blocks that are cached, then the disk need not be accessed and the transfers are so fast that they approach memory-disk performance.

When designing a caching system you have to decide how much memory, or number of buffers, will be allocated for disk-block copies. Decisions behind caching with large amounts of memory allocated for the cache (256K bytes is typical) were discussed in "Maximizing Hard-Disk Performance" by Roy Chaney and

(continued)

Brian McKeon is an Australian with a Ph.D. in medicine. He recently completed two years of research at MIT supported by a grant from the National Health and Medical Research Council of Australia. He can be contacted at 1-18 Manion Ave., Rose Bay, Sydney, Australia.



ILLUSTRATED BY DAVE RIDLEY

Listing 1: *Routines for buffer manipulation, buffered block, and character I/O.*

```
/*
Buffer manipulation, buffered block, and character I/O routines.
*/
#include            "xdefs.h"        /* system-wide definitions */

#define BLKSIZ 512                   /* disk-block size */
#define NBUF 18                      /* number of block
                                        buffers in cache */

#define XBFLGS   0                   /* flags for a buffer */
#define XBDEV    1                   /* device and block of which */
#define XBBLK    2                   /* this buffer is a copy */
#define XBAGE    3                   /* "time" of last access */
#define XBFREQ   4                   /* frequency-of-access parameter */
#define XBUF     5                   /* start of actual buffer */

#define XBFREAD 01                   /* buffer header bit flags */
#define XBFWRIT 02

#define XBUFSIZ   (XBUF+(BLKSIZ/2))  /* buffer plus header size */
#define MINRDBUF   (NBUF/3)          /* cache flush threshold */
extern  int        tracefg,          /* debug tracing flag */
                   *sysproc;         /* ptr to system process descriptor */
int     *freebuf,                    /* free buffer list pointer */
        bufpool[NBUF*XBUFSIZ],       /* pool of buffers and headers for each */
        devioage;                    /* counter of calls to buffered I/O func */
/*
Initialization of buffer management.
'freebuf' is a pointer to the first free buffer on the free list.
If the free list is empty, 'freebuf' will be 0.
*/
bufinit( )
{
        int         k, *ip;
        printf("buffer pool at %d/n",bufpool);
        freebuf = 0;    /* freebuf = = 0 will indicate end of free list */
        ip = bufpool + XBUF;     /* point at start of first buffer */
        for(k = 0; k < NBUF ; k++)
                {
                buffree(ip);           /* and free up all buffers */
                ip = ip + XBUFSIZ;
                }
}
/*
Return a buffer to the pool.
Range checking has been removed
as this function is only called by the system.
*/
buffree(buf)
int *buf;              /* note usage as array of int for correct pointer maths */
{
        buf = buf - XBUF;           /* back up to address
                                       of buffer header */
        buf[XBFLGS] = 0;            /* clear all flags */
        buf[XBFLGS + 1] = freebuf;      /* link onto free list */
        freebuf = buf;
}
/*
Allocate a buffer from the pool.
Look for the buffer with the lowest frequency of use and,
if more that one with the same value, choose the least
recently used (LRU) one.
```

(continued)

Random replacement, FIFO, and LRU are decision algorithms for copy displacement.

Brian Johnson (May 1984 BYTE, page 307). In the case of the Tonto operating system, a large process and a couple of smaller processes left little room for a large cache and forced an 18-block (9K-byte) cache size. This restriction of a small cache is typical of many other applications where caching is implemented as part of a program, for example, programs for CP/M on 64K-byte machines.

The next design question—which copy should be displaced—arises when all cache buffers contain copies of disk blocks and a request is made for a block that is not in the cache. The decision algorithms in common use are random replacement, first-in/first-out (FIFO), and least recently used (LRU). Chaney and Johnson didn't find much difference in performance with large caches; however, the algorithm becomes very important when small caches are involved. To see why, we can look at typical activity in a large cache.

Much operating-system disk activity is concerned with opening, reading or writing, and closing files. It is obvious that a lot of this activity will involve reading and writing to directory blocks; therefore, it is desirable to try to keep copies of these blocks in the cache. After opening a file, the cache will contain copies of directory blocks. Reading a file will cause copies of its blocks to displace other copies in the cache. With large caches, the size is larger than most files and, when it comes time to open another file, the copies of directory blocks will probably still be in the cache. This will apply to any blocks that are accessed often; the chance of finding them in the cache will be higher than for other blocks that are used less.

(continued)

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```
If the number of read-type buffers is below the minimum,
flush any write buffers.
*/
bufalloc( )
{
        int *ptr, *ip, k, age, oldest, freq, nrdbuf, nflush;
        if(freebuf)             /* any buffers on free list? */
                {
                ptr = freebuf;      /* point free-list pointer to next on list */
                freebuf = freebuf[XBFLGS + 1];
                fillw(ptr + XBUF, SYSDSEG, 0, BLKSIZ/2);   /* fill with null */
                return (ptr + XBUF);
                }
        ptr = bufpool;          /* otherwise look for a 'READ' buffer */
        nrdbuf = 0;             /* counter of number of 'READ'
                                   buffers found */
        ip = 0;                 /* 'ip' will be nonzero if a 'READ'
                                   buffer found */
        freq = 32767;           /* hunt for XBFREQ less than this (a big
                                   number) */
        oldest = 0;             /* hunt for a buffer older than this */
        for(k = 0; k < NBUF ; k++)
                {
                if(ptr[XBFLGS] & XBFREAD)       /* a READ-type buffer */
                        {
                        nrdbuf++;
                        if(ptr[XBFREQ] <= freq)
                                {
                                freq = ptr[XBFREQ];
                                age = devioage - ptr[XBAGE];
                                if(age > oldest)
                                        {
                                        oldest = age;
                                        ip = ptr;  /* save it */
                                        }
                                }
                        }
                ptr = ptr + XBUFSIZ;
                }
        if(nrdbuf < MINRDBUF)
                nflush = bufsflush();       /* record number flushed */
        if(ip)  /* was a READ buffer found? */
                {
                buffree(ip +XBUF);     /* free it up */
                return bufalloc( );     /* and try again */
                }
        else if(nflush)  /* were any write buffers flushed? */
                return bufalloc( );
        else    stop(''bufalloc/problems'');
}
/*
Buffered block I/O function.
Give device, read/write, desired block, address of data, and ID
of process requesting I/O.
Returns number of bytes transferred.
*/
bufdevio(dev, rwfn, blk, addr, proc)
int *dev, rwfn, blk, addr, *proc;
{
        int     *ip;
        return cbufdevio(dev, rwfn, blk, 0, BLKSIZ, addr, proc);
}
/*
```

(continued)

With small caches the reading of most files will displace any block copies that were in the cache before the file was read. This problem can be avoided for copies of directory blocks by having a separate cache for that information. Instead I have developed a more general scheme that responds to frequent demand for any blocks. The key to a better technique is to measure the frequency of access to a block copy and use this information when deciding which copy to displace. The LRU and FIFO algorithms are based on frequency of access, but they are approximations of frequency of access and they break down with small cache sizes. I will describe a simple technique that is more applicable in these situations.

Algorithm and Implementation

Figure 1 shows the data structure of the cache used in the listing. The C compiler used to develop the routines is a much-modified version of a public-domain program ("A Small-C Compiler" by Ron Cain, *Dr. Dobb's Journal*, May 1980, page 176), which has been tailored for the 8088/86 processor. It does not recognize structure syntax, so the buffers and their headers are declared as integer arrays in the listing.

Each buffer in the cache has associated information that specifies the block and device from which it has been copied. In addition, flags are included to indicate if the buffer copy has been altered and not yet written to disk. The other parameters, XBFREQ and XBAGE, are used when deciding which copy to displace when the cache is full and a buffer is requested.

Whenever a block copy is found in the cache (a "hit"), the frequency-of-use parameter (XBFREQ) is increased. When a block copy is not in the cache (a "miss") and no buffers are free, the cache is scanned to find the block copy with lowest frequency of use (lowest XBFREQ) and this copy is displaced. If multiple copies with same lowest frequency of use are

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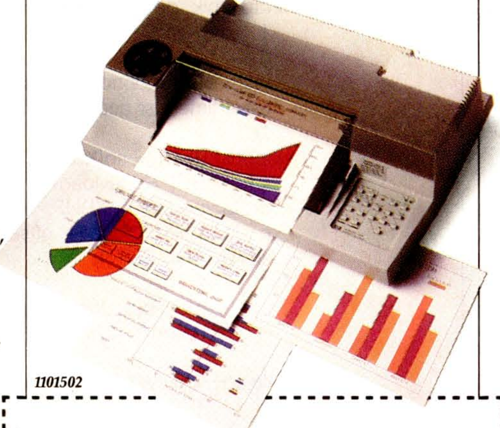
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```
Buffered character I/O function.
Give: device, read/write, desired block, offset in block
at which transfer is to occur, number of bytes to transfer,
address of data, and ID of process requesting I/O.
Returns number of bytes transferred.
*/
cbufdevio(dev, rwfn, blk, offset, nbytes, addr, proc)
int *dev, rwfn, blk, offset, nbytes, addr, *proc;
{
        int *ip, *buf, k, c_locn;
        if(traceflg > 2)
                printf("cbufdevio(%d, %d, %d, %d, %d, %d, %d)/n",
                        dev, rwfn, blk, offset, nbytes, addr, proc);
        if((offset < 0) | (nbytes < 0))     /* check for bad arguments */
                stop("bufdevio negative arg");
        if((offset + nbytes) > BLKSIZ)
                stop("bufdevio request too big");
        if(nbytes == 0)
                return 0;
        devioage++; /* bump access counter */
        if((devioage & 017) == 0)     /* i.e., every 16 times called */
                { /* 'decay' all XBFREQ values by one half (rotate) */
                ip = bufpool;
                for(k = 0; k < NBUF ; k++)
                        if(ip[XBFLGS] & XBFREAD)  /* a READ-type buffer */
                                ip[XBFREQ] = ip[XBFREQ] >> 1; /* halve */
                }
        if(ip = findblk(blk, dev)) /* this device block in a buffer? */
                {
                /*
                increase frequency of access count and
                reset time last accessed
                */
                ip[XBFREQ] = ip[XBFREQ] + 128;
                ip[XBAGE] = devioage;
                c_locn = ip + XBUF;        /* get address of start of buffer */
                c_locn = c_locn + offset;  /* and transfer address */
                if(rwfn == RDFN)           /* transfer from buffer */
                        {
                        movsb(c_locn, SYSDSEG, addr, proc[PRDSEG], nbytes);
                        return  nbytes;
                        }
                if(rwfn == WTFN)  /* transfer to buffer and mark as WRITE */
                        {
                        movsb(addr, proc[PRDSEG], c_locn, SYSDSEG, nbytes);
                        ip[XBFLGS] = (ip[XBFLGS] & (~XBFREAD)) | XBFWRIT;
                        return nbytes;
                        }
                }
        /*
        the device block is not in the pool,
        allocate a buffer and read the block
        and do the requested transfer
        */
        buf = ip = bufalloc();
        ip = ip - XBUF;  /* back up to start of buffer header */
        ip[XBDEV] = dev;  /* set up header except for flags */
        ip[XBBLK] = blk;
        ip[XBAGE] = devioage;
        ip[XBFREQ] = 0;
        /*
        if a full block is to be written then
        it is not necessary to read the old block
        contents into the buffer
```

(continued)

Copies that stay in the cache have a better chance of being hits.

found, then the copy that has not been used for the largest amount of time is displaced. This latter decision is made using the XBAGE parameter.

It's obvious that copies that stay in the cache have a better chance of being hits and, therefore, the XBFREQ parameters of these buffers will continue to increase. This parameter is "decayed" over time, otherwise some block copies would become locked into the cache. The method used to perform this decay is to halve the XBFREQ parameter of all buffers after every 16 calls to the buffered input/output (I/O) routine. Both halving and testing for every 16th call are implemented by rotates and masking for speed reasons. To gain better resolution in the selection of which buffer to displace, the XBFREQ parameter of a buffer is increased by 128 with each hit.

If, for other applications, you alter any of these values, then see if overflow of the XBFREQ parameter can occur. This parameter cannot overflow with the given values even if the same block is accessed repeatedly. (The maximum value that XBFREQ can attain is $16*128 + 0.5*16*128 + 0.5*0.5*16*128 \ldots$, which approaches $2*16*128$, a safe limit.)

The algorithm is best illustrated by an example: With the Tonto operating system, when a file is opened, a directory block will be accessed typically 32 times as the directory entries in that block are scanned. In the worst case, this block would not have been in the cache and would start with XBFREQ zero. After the 32 accesses, XBFREQ would be $24*128$ ($[16 + 0.5*16]*128$) and subsequent file reading will halve XBFREQ for every 16 blocks read from a file. When the

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```
        */
        if((nbytes == BLKSIZ) & (rwfn == WTFN)) /* write full block? */
                {
                movsw(addr, proc[PRDSEG], buf, SYSDSEG, BLKSIZ/2);
                ip[XBFLGS] = XBFWRIT;  /* mark as WRITE */
                k = BLKSIZ;  /* return value */
                }
        else    /* fetch physical block for reading or updating */
                {
                if(devio (dev, RDFN, blk, buf, sysproc) == ERROR)
                        {
                        buffree(buf);
                        k = 0;
                        }
                else    {
                        ip[XBFLGS] = XBFREAD;
                        k = cbufdevio(dev, rwfn, blk, offset,
                                nbytes, addr, proc);
                        }
                }
        return  k;
}
/*
If a device block is in the buffer pool, return
the address of the buffer, else 0.
*/
findblk(blk, dev)
int     blk, dev;
{
        register int *ip;
        int     k;
        ip = bufpool;
        for(k = 0; k < NBUF ; k++)
                {
                if(ip[XBFLGS]&(XBFREAD | XBFWRIT)) /* a device-block image */
                        if(ip[XBBLK] == blk) /* do more rare test first */
                                if(ip[XBDEV] == dev)
                                        return  ip; /* a hit */
                ip = ip + XBUFSIZ;
                }
        return  0;              /* a miss */
}
/*
Flush all pending writes in the buffer pool
and convert write status to read.
Return the number of buffers so changed.
Writing of buffers is performed in order to
minimize head movement across the disk.
Sectors on the same track will also be written
in order.
The order is from highest device ID to lowest
and lowest block number to highest.
*/
bufsflush( )
{
        int *ip, nwrt;
        nwrt = 0;       /* counter of buffers flushed */
        while(ip = buf_w_next( )) /* find next in order */
                {
                devio(ip[XBDEV], WTFN, ip[XBBLK], ip + XBUF, sysproc);
                ip[XBFLGS] = (ip[XBFLGS] & (~XBFWRIT)) | XBFREAD;
                nwrt++;
```

(continued)

XBFREQ parameter of the directory block falls below 128, that block copy will be displaced in favor of block copies that have been accessed only once (XBFREQ = 128). This will not occur until XBFREQ of the directory block has been halved 5 times, which happens after 80 (5*16) file blocks have been read. This is a distinct improvement over simpler techniques where the copy of the directory block would be lost after only 18 blocks (9K-byte cache) had been read. If another file is opened before the copy of the directory block has been displaced, then the directory block's XBFREQ parameter will be refreshed. Alternatively, if some file blocks see a lot of accesses (e.g., parts of an editing program's temporary file), then the cache will try to hold onto the copies of these blocks and it will displace the directory block copy.

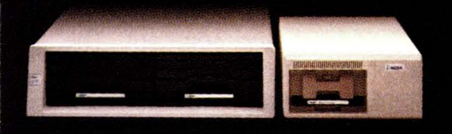
If, in other applications, the size of the cache is increased, then the cache should respond more slowly to changes in demand and the decay should be decreased. One way to achieve this is to halve the XBFREQ parameters less often (e.g., every 32 or 64 accesses).

Another aspect of this caching system that leads to a dramatic speed improvement is the way altered block copies are written to disk. Many programs are concerned with the reading of one file and the writing of another. The ideal method to maximize speed is to have programs read and write in large chunks. In any multiprocessing system, this solution is inefficient, as all such programs would have large I/O buffers built in and would require more memory to operate. It is more memory-efficient to centralize the buffering in the operating-system cache. (This has the added benefit that all processes "see" the same disk image; this would not be true if each process had a separate buffer.) In the caching system described in this article, writing or "flushing" occurs when a buffer is requested and the number of altered buffers is found to exceed a predetermined threshold. (It is also good practice to flush the cache

(continued)

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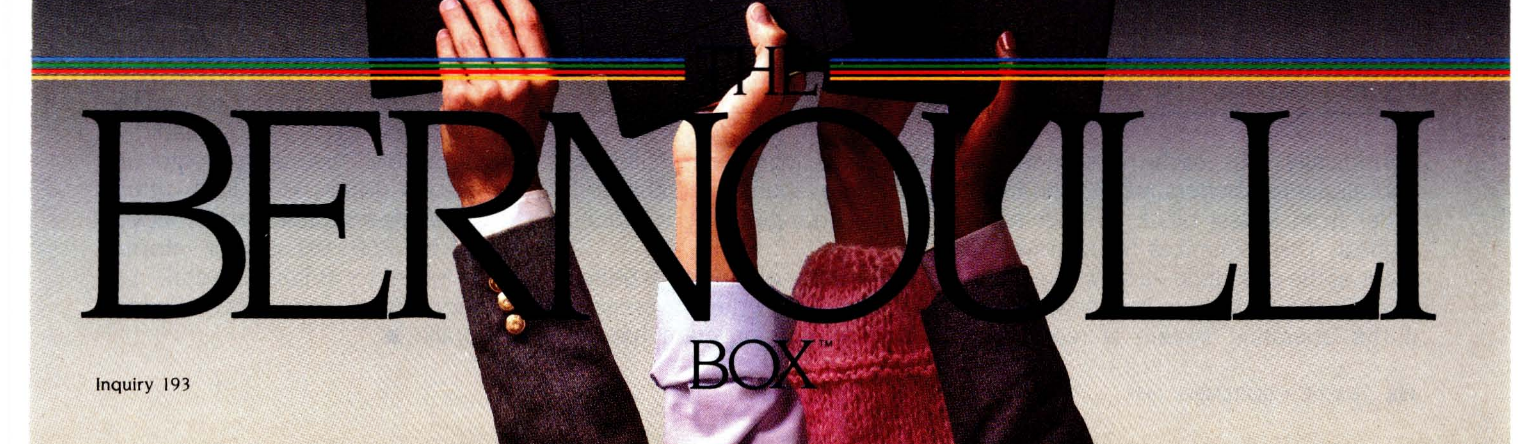
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```
                }
        return     nwrt;    /* number of buffers written */
}
/*
Scan the buffer pool for buffers marked as WRITE
and return the address of the one with greatest device ID
and lowest block number. If none found, return 0.
*/
buf__w__next()
{
        register int        *ip, k;
        int          *devmax, blkmin, rval;
        devmax = 0;                 /* a small, impossible, ID number */
        blkmin = 32767;             /* the biggest block number */
        rval = 0;                   /* default return value */
        ip = bufpool;
        for(k = 0; k < NBUF ; k++)
                {
                if(ip[XBFLGS] & XBFWRIT) /* a WRITE buffer ? */
                        {
                        if(devmax < ip[XBDEV]) /* larger device ID? */
                                {
                                devmax = ip[XBDEV];
                                blkmin = ip[XBBLK];
                                rval = ip;         /* save it */
                                }
                        else      /* same device, smaller block number? */
                                if(devmax = ip[XBDEV])
                                    if(blkmin > ip[XBBLK])
                                        {
                                        blkmin = ip[XBBLK];
                                        rval = ip;
                                        }
                        }
                ip = ip + XBUFSIZ;
                }
        return     rval;    /* zero or ptr to next block/dev buffer */
}
```

```
struct  xbuf                    /* a cache buffer */
        {
        int          xbflgs;    /* buffer flags */
        int          xbdev;     /* device block of which the buffer is a copy */
        int          xblk;
        int          xbfreq;    /* parameter for frequency of use algorithm */
        int          xbage;     /* parameter for LRU algorithm */
        char         buf[BLKSIZ];   /* buffer proper */
        }
                     bufpool[NBUF];   /* the cache of 'NBUF' buffers */
```

Figure 1: *Structure of the cache area.*

periodically.) The cache is scanned and all altered buffers are written in order from lowest block number to highest. This minimizes head movement of the disk drive—a slow operation. To the disk drive it appears as if the operating system is reading large chunks from some files and writing large chunks to others, the idealized arrangement mentioned earlier.

There is a penalty when writing in this manner: Disk-write errors can occur long after a program has performed the write request. The disk-driver function devio goes to extremes in the correction of write errors but for other applications this may not be possible, and thus only block-read caching would be appropriate.

The listing should be largely self-explanatory except for three external functions. One is movsb; this is a call to a machine-language function that transfers a number of bytes from one address and segment (8088/86) to another address and segment. A second function is devio; it transfers a block to/from a floppy-disk device from/to a given address and segment. The passed-process descriptor is used to determine the transfer segment as for the movsb function. All of the process/segment parameters and even the movsb function could be eliminated when using these routines in many applications. A third function is stop; an error message is passed to it and it prints this message before halting.

CONCLUSION

This caching algorithm has proven successful on a small multiprocessing operating system. It can be applied when caching is desirable and memory space is at a minimum, such as intelligent line buffering within editors and record buffering in database managers.

The routines help to illustrate a general point that has been made by many authors: The use of a high-level language enables the easy development of fast algorithms, often producing an end product that has equal, if not better, performance than routines written in assembly language.

The full source code of the Tonto operating system (over 100K bytes) and various utilities (over 200K bytes) including file-system checker and file-system debugger are available in bootable IBM Personal Computer (PC) or Sanyo MBC 55X form (three double-sided double-density floppy disks) for $60. For further information, write to Brian McKeon, 1-18 Manion Ave., Rose Bay, Sydney, Australia. ■

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BY A. G. W. CAMERON

ASTROPHYSICAL NUMBER CRUNCHING

My experiences with a progression of "personal" computers across the years

I have used personal computers to do number crunching for my work in theoretical astrophysics for rather a long time. It is only in recent years that I have used the term "personal computers" to describe the machines I used, but they had many of the attributes of personal computers. The principal difference was that the earlier machines were not dedicated to only one user. However, in general, only one or two people could use one of these machines at any one time.

THE FIFTIES

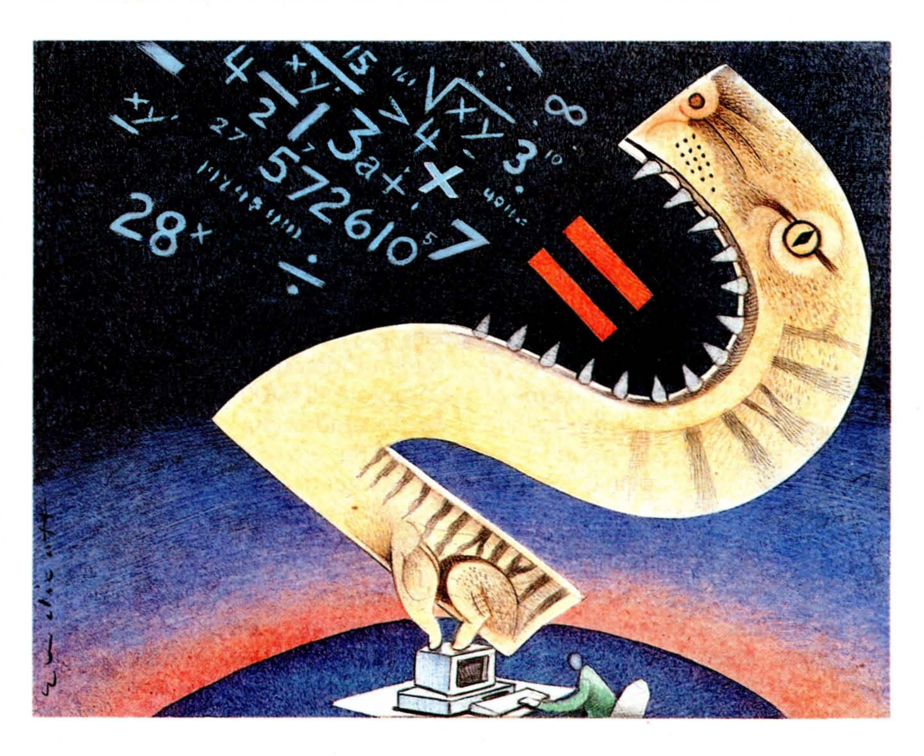
In the early days of computing you didn't have the option of using a computer like today's mainframes because such machines did not exist. In the middle and late 1950s, I was working at the Canadian Atomic Energy Project at Chalk River, Ontario. We started using the IBM 602A accounting machines for calculations. These were mechanical devices with relays, counters, and registers; they used a plugboard in which you inserted wires to direct the operations to be performed on the cards passing through the machine—at a rate of about six cards per minute. One of my colleagues converted these machines into card-programmed calculators by placing germanium diodes in the wires. The machines then read their instructions from the cards themselves. I would do calculations with several trays of cards. Apart from very limited storage space, the principal difficulty was the lack of any IF . . . THEN . . . ELSE capability.

Nevertheless, we did useful work. I remember exploring the properties of helium thermonuclear reactions at that time. At a somewhat advanced stage in the evolution of a star, the helium in the interior burns into carbon, oxygen, and small amounts of neon. This gives three simple but nonlinear differential equations to be integrated simultaneously. I did these on the computer for a variety of cases that spanned the range of uncertainties in the parameters' values.

In 1958 we got a Datatron 205, one of the new "small" computers that came out at that time; it was similar to, but better than, the IBM 650, which was then popular. The Datatron 205 was an electronic-tube machine

(continued)

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ILLUSTRATED BY JAMES ENDICOTT

For the first year we had the Datatron 205, not very many people knew what to do with the computer.

with 4000 words of storage on a rotating mechanical drum; its speed was similar to that of a modern microcomputer using interpreted BASIC. You programmed it in machine code, which wasn't too bad because everything was in decimal. It was a one-user-at-a-time machine, and you debugged your programs at the console, using absolute addresses. It was substantially interactive, since you could pause it at any time to examine the contents of any address locations and output that information on an attached printer.

For the first year we had it, not very many people knew what to do with the computer, so I had it to myself many nights and most weekends. I would come in to check on things on Saturday and Sunday, and if the machine was down I could generally get it back up with a kick or by swapping out an electronic-tube module that showed an invalid combination of lights. In 1959 I went away for a year, and when I came back everything had changed. People then knew what to do with computers, and it was very hard to get substantial access time.

The first year we had the Datatron 205 was incredibly productive for me scientifically. I explored the stages of nuclear burning beyond the helium stage (carbon, oxygen, neon, magnesium, and silicon burning) in the interior of a massive star. This involved the simultaneous integration of substantial numbers of differential equations for large numbers of nuclear species, as the temperature in the stellar interior rose and new sources of thermonuclear reactions became active. By numerical integration I evaluated the rates of those nuclear reactions that take place under conditions of very high density rather than high temperature—pycnonuclear reactions.

I also began experimenting with models of neutron stars; this involved integrating two simultaneous differential equations of stellar structure with an auxiliary equation for the relation between pressure and density—the equation of state. This work thoroughly convinced me of the advantages of an interactive computing environment where you can see what's going on as your calculation progresses.

THE SIXTIES

During the next period of my life I did relatively little computing, and none of it "personal." This was the era of the mainframe with its accompanying crew of "high priests." I was at the NASA Goddard Institute for Space Studies in New York. At first we had an IBM 7094, and later an IBM 360/95. All our computing was batch processing using FORTRAN. I found this environment so "unfriendly"—a term not used at the time—that I preferred to accomplish my projects through the students and postdoctoral research associates who were working with me.

THE EARLY SEVENTIES

In 1973 I came to Harvard University. The Center for Astrophysics was being established at this time to coordinate the research activities of the Harvard College Observatory and the Smithsonian Astrophysical Observatory. Our computing was still in batch mode on a CDC (Control Data Corporation) 6400 mainframe, which was located about a mile away from us. But the era of the small computer was at hand. I obtained a Hewlett-Packard 9830 programmable desktop calculator with an attached 5-megabyte hard disk. I have often wondered why histories of personal computing ignore this machine and others like it. It used interpreted BASIC in ROM (read-only memory) and had 16K bytes of available user memory. Shades of the old Datatron 205—but better—and all to myself! It was quite a while before the better-known hobby machines, starting with the Altair, could match the capabilities of the HP 9830.

By this time, using computers in theoretical astrophysics was commonplace. My interests had shifted into investigations about the origin of the solar system. This is a complicated interdisciplinary subject dealing with a complex physical and chemical scenario, and much of the work in it involves computational simulations of system structures and their evolution across time. These systems include the sun and planetary bodies and the hypothetical solar nebula from which we believe they were formed.

The following are among the problems I remember working on with the HP 9830:

- A series of Monte Carlo calculations of collisions between small solid particles (originally interstellar grains). The purpose was to see how the particle sizes vary due to coagulation and disruption during the collisions. This involves storing the abundance (amount of material present) of particles of a given size in bins and moving those abundances between the bins as particles grow or are shattered.
- Calculations of the periods of radial and nonradial oscillations of hot-white dwarf stars. For a star of given mass and for a given class of oscillations, the frequency of oscillation must be varied in small steps so that you can determine when the center and surface boundary conditions of the oscillations are satisfied. For the nonradial oscillations this involves the simultaneous solution of five differential equations.
- The structure and evolution of the primitive solar nebula. In this problem you must determine the structure in the radial direction (along the radius) and, for each of a series of radial steps, in the vertical direction. Mass, angular momentum, and energy are transported in the radial direction as

(continued)

PS Computers Presents the. . .

PS Turbo 640

For those of you that mistook me for Bill Gates from Microsoft, let me clarify things. I'm Dave Carlin of PS Computers in Palm Springs, California. The differences are pretty basic. Bill reads the Wall Street Journal, wears glasses and writes great software. I read USA Today, wear soft contacts and build great hardware.

Now that you know who I am, or at least who I am not, let's get to the point.

Problem. Since I got into computers two years ago they have been a constant source of fascination and frustration.

Fascination due to the immense power and control that the personal computer has allowed me over my daily business activities; frustration due to the hundreds of hours I've spent making hardware and software cooperate with one another.

No doubt about it, once you get all the pieces put together correctly you have at your command an incredible tool. There is absolutely no limit to the number and type of tasks that you can accomplish with greater speed, better accuracy and stronger impact; all with far less effort. The trade off however has been the time, energy and uncertainty involved in finding the best buy on the right equipment, then getting all the parts to function as one.

Because I have personally gone through hours of long distance phone calls to hardware manufacturers and waited days for call backs that never happened. Because I have found myself so many times in front of a screen filled with meaningless greek characters at 2 AM unable to get the computer to print a simple business letter. Because I would not wish this type of agony on anyone. This is why I have put together the PS Turbo 640.

Solution. What happened was. . .a few months ago I discovered a source of computer mother boards that run IBM type software faster than the IBM PC. They're a genuine product of Taiwan and they are beautiful. I bought cases, keyboards, cables and disk drives; built the Turbo 640 and put it to work. Right now I have three PS Turbo 640s linked as a network running Dbase III and Lotus day in and day out in my business. The PS Turbo 640 works, it works well and it works faster than the IBM PC.

An oral surgeon friend saw my network and asked me to build one up for him. One of the Turbo 640's on the network is in his operatory. It runs a program I wrote in Turbo Pascal for his anesthesia records - not a single glitch. (The 640 seems totally immune to the effects of Nitrous Oxide.)

More than compatible. Though I have a private pilot's license and quite a few hours flying high performance aircraft, I've never taken the time to learn to use the Flight Simulator program from Microsoft. Some of my friends have and it runs beautifully on the 640.

The phrase "IBM compatibility" is an understatement with my computers; the PS Turbo 640 is just flat out a better machine.

Peter Norton publishes a program that rates computers as to speed and compatibility with the IBM PC. In the normal mode of operation the PS Turbo 640 rates a 1.0 which indicates a 1 to 1 equivalency. In the high speed mode (selected with two keystrokes, no switches or rebooting) the 640 scores a 1.4; that's 40% faster than an IBM PC.

The specs. 640 K of memory (the maximum contiguous memory that the PC can address - and they're all 150 nanosecond chips). A keyboard that is very similar to the Key Tronic KB5151 (yes all the horror stories about the keyboards that come stock with IBM PCs are true). Two serial ports, a parallel printer port and a game port (you can't beat that). Battery powered clock (keeps track of the time and date while the computer is off). A video card that gives you crisp monochrome text and also displays color/graphic software on a monochrome monitor as sixteen shades of grey (amber). An amber monitor (very chic). Two 360 K disk drives (AKA Half Height DSDD). Two front panel LEDs (one to indicate that you left the computer on from the night before [it's ok, that doesn't hurt it] and the other to tell you if the processor is in the high speed mode or just going IBM speed). Eight expansion slots (two are used by the multifunction card and monitor card, four full sized and two short slots are available) Five available ROM sockets and two buss connection points (load programs stored on your own ROMs). 135 watt power supply (ready for upgrading to a hard disk). User's book and complete technical information (the user's part is easy - the tech part is very technical).

A computer without software is basically a solid state boat anchor and a rather poor one at that. When you buy the Turbo 640 I want you to be able to start using it the moment you take it out of the box.

All this and software too. First there's PC DOS 2.10. DOS is the program that brings the computer to life. Typically some version of it is run on all IBM PCs prior to running application programs. "And it came to pass that this was called booting the computer". I'm not crazy about the term, but everyone does it. The full DOS manual is included.

There is complete software for the multifunction card that allows you to partition the 640's memory into RAM disks and a printer buffer.

Perhaps you've heard about Sidekick from Philippe Kahn at Borland. InfoWorld voted it the Software Product of the Year. Well it's good code but I'm not including it with the Turbo 640. What I am including is a product that I like better, has essentially the same functions but in my opinion is easier to use - PopUps from Bellsoft. Regardless of how deep into your spreadsheet, database or master's thesis (revisions) you might be, two key strokes will put a notepad, calculator or any of 5 other utilities on your screen. Make notes, perform calculations, set an alarm, check your calendar or perform DOS functions. When you're finished just hit the escape key; the PopUps disappear from the screen and you're back into your program. This is the PopUp Deskset from Bellsoft, it's potent software and it's part of the PS Turbo 640 system.

Don't wait. If you're ready for this kind of computing then the PS Turbo 640 is the machine you need. Call me with your American Express Card account number or mail me a cashier's check. I will personally see to it that a Turbo 640 is shipped to you via UPS the next business day. Open the box, plug the monitor and the keyboard into the computer then plug the computer into the wall socket. Turn the computer and monitor on, stick in any software designed to run on the IBM PC and go to work. No chips to put in backwards, no little multicolored wires to push onto the wrong connector and no switches to set.

Money back. If the PS Turbo 640 doesn't perform like I've said then return it to me. Just put one copy of your invoice in the box and send it back. I will make sure that credit is issued on your credit card or a cashier's check is mailed out to you, the same business day that we receive the unit.

I've told you quite a bit about what you get when you buy the Turbo 640; now let me tell about something you won't get. You won't get put on hold if you have occasion to call the technical support division number. That's because there isn't a technical support number. Once the machine is on it looks like, acts like and runs like a properly configured IBM PC, just a little faster.

This is the part where I have to get a little tough. I've sold you what I feel is the ideal configuration of an IBM type PC. You have gotten the absolute best buy for your money on earth. I can not however, learn how to use it for you. Follow the directions in the book, remember that no matter how much you pay for your software it's probably not perfect, and most of all don't give up - whatever time it takes to get proficient at your particular software application will ultimately be all worthwhile.

If you have questions concerning operation (that aren't answered by the manual), you have three options:

One, write me a card or letter. All correspondence is answered the same day as received via MCI Mail. Two, sign onto the PS Computer 24 hour bulletin board, post your message and then sign on later for the answer. (admittedly hard to do if you didn't decide to get a modem or the computer I sold you broke [see option one]) Or three, find out where I live (probably the least convenient for both of us).

Warranty. The warranty on the Turbo 640 is simple. If anything goes wrong in the first six months, send it back. The unit will be repaired and shipped back to you two days after we receive it. After six months? Same thing, small charge.

Placing your order. The 800 number puts you in touch with an operator here at PS Computers whose function is to take the necessary information, quickly and accurately, period. I've given you the highlights of the system in this ad. If you need to know more about specific features drop me a line. Sure it seems like it might be a bit more trouble than calling; but you won't be reaching a busy signal and your answer will be in writing.

You have my word that the PS Turbo 640 has been accurately represented on this page and is in fact the absolute best buy for your dollars. If for any reason you don't like the 640 then you also have my word that upon our receiving the system, those dollars will be returned to you, immediately.

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Inquiry 302

a result of friction due to turbulent viscosity in the nebula, and, depending on the rates of these transport phenomena, energy dissipation occurs in which the energy deposited must be transported to the surfaces of the nebula and radiated away there. We ran a half-dozen cases with different input parameter values.

The last problem took more than half a year to run. I developed a technique for starting and stopping a problem. The HP 9830 had an attached thermal printer, so that I could get a printout of the run status at various intervals; the current values of all the variables were stored to disk at frequent intervals also. Thus, if a problem stopped, either by a deliberate action or by a power failure or whatever, it was a simple matter to restart it from the last disk-storage event. In fact, a problem's initial conditions were usually stored in an appropriate disk file where the main program could read them as it began.

THE LATE SEVENTIES

Nevertheless, the third problem ran along interminably; we needed a much faster machine—a minicomputer. In 1976 we upgraded to a Data General Nova 3/D computer. In its final configuration the Nova 3/D had 256K bytes of memory and ran a decent version of a FORTRAN compiler. It supported up to two users, each using one "ground" (foreground or background). After excluding the operating system, each user had an average of 110K bytes of RAM (random-access read/write memory) using memory-mapping techniques. This was not quite as "personal" as some of the other machines I used.

Later we added a Data General Nova 4/X computer. Dual ports connected both of these computers to two hard disks. By this time, the Center for Astrophysics was running a Digital Equipment Corporation VAX-11/780. Our benchmarks showed the Nova 3/D to run a number-crunching problem typically at 25 percent of VAX speed and the Nova 4/X at 45 percent, each running with only one ground. When both grounds were active, a given ground ran more slowly, but the total throughput was about 50 percent higher.

Our work was supported by government grants. On a given grant the best you could expect to have approved was a few thousand dollars—at the most about $10,000—for computing time to be purchased from the central university computer. I have always felt that I can get much more computing per dollar by using small machines like personal computers; therefore, if I have to put up with certain inconveniences in order to do so, I will. For example, note from the speeds outlined above that if all four

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grounds are used very efficiently, we can get a throughput comparable to that of our central VAX. The computing budget for our central computing facility a few years ago, when these comparisons were made, was about $600,000 per year and often more. This was financed by user charges. Thus, we could claim that we had the potential of doing the equivalent of $600,000 worth of computing per year. In fact, we were rarely that efficient. It is probably closer to the truth to say that we got about $200,000 to $300,000 worth of computing per year at a real cost equal to a tiny fraction of this. (Many other installations have operated their VAXes at much lower costs. Often they do not include depreciation of the original purchase in the running charges and use few if any hired operations personnel.)

The Novas were 16-bit machines, and the techniques of using memory mapping were anything but transparent to the user. Fortunately, the operating system was not included in user address space, but code and data did have to fit into 64K bytes. There were various ways of doing this for a large program. You could divide the code into overlays and explicitly load each overlay segment as needed; often the overlay scheme became very complicated. You could keep the data in extended, or virtual, memory and access it by moving a window around via calls to special FORTRAN subroutines and functions. You could write (or read) the entire virtual memory to (or from) disk. We quickly learned the value of making programs restartable in case someone or something crashed the system.

Despite these inconveniences, we did a lot of sophisticated programming. The following are some of the major programs we ran on the Novas:

- Neutron-capture nucleosynthesis on a rapid time scale. We investigated whether this process, which takes place somewhere in stellar systems, could be taking place through the production of neutrons by helium thermonuclear reactions, either in the helium zones of supernova explosions or deep in the helium cores of stars in an advanced stage of evolution. Our conclusion was that it was not. We needed to solve a very large number of differential equations simultaneously, since nuclear transformations interconnect more than 6000 nuclear species, and we had to evolve their abundances forward in time.
- Stellar evolution. Here a stellar model is divided into concentric spherical zones, and the four simultaneous differential equations of stellar structure are rewritten as difference equations applied to the zone boundaries. In effect, this produces

(continued)

 Inquiry 409 Inquiry 339 →

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four such equations per zone; we could handle up to 200 zones. We obtained a satisfactory solution for a stellar model by iterating changes in the conditions at the zone boundaries and computing additional models as the star evolved in time. If we had used realistic input for the physical quantities in this problem, the time required to compute, for example, the equation of state or the radiative opacity literally millions of times would have been too demanding. So we put these quantities into two tables on disk, each some 5 megabytes long, and read the records into windows in memory so we could interpolate it. We also ran a similar kind of program to study the evolution of giant gaseous planets.

• Astrophysical hydrodynamics. The stellar-evolution program just described is an example of hydrostatics; when velocities and accelerations in the system become important, then we have hydrodynamics. The hydrodynamics of a spherically symmetric case are similar to those of stellar evolution, except that the differential equations have more terms. (We have studied stellar oscillations this way.) However, we have run problems in cylindrical geometry that are somewhat more demanding. In such a problem conditions along the cylindrical axis differ from those perpendicular to that axis, so that you must set up a mesh of points representing a grid laid out along the axis and representing concentric circles in planes perpendicular to that axis. In a typical case we used a mesh of 32 by 64—a total of 2048 mesh points. Again, you must solve differential equations at each of the mesh points. We typically used this code to study the flow of gas past a star, as when a supernova goes off in a binary system or a star is immersed in a dense gas cloud in a galactic center. We have also used a different kind of hydrodynamic representation more suited to intrinsically three-dimensional motions. Here the available space is divided into cells, and the motions of test particles are followed through these cells (hence, this method is called the "particle-in-cell" method).

• Structure and evolution of the primitive solar nebula. This is essentially the same problem I described earlier, but with the Data General Novas we could do it with improved physics and in much greater detail.

The Early Eighties

With programs like these running, frequently for weeks on end, and with demands on the Novas for word processing, graphics, and other program development, it had become difficult to get computing time by 1982. At that time Data General modified the operating system for the Novas to allow RAM to be expanded to 512K bytes. Although we would clearly have benefited by adding the extra memory, I decided not to. That marked the beginning of our transition to microcomputers. The memory addition for the Nova 3/D would have cost $3000, and for the Nova 4/X, $5000. But 256K bytes of microcomputer memory cost only a small fraction of those amounts at that time. (Today it would cost less than $100.) For a price comparable to either of these memory additions, I could buy an entire microcomputer. So I started in that direction, first with Otrona Attaches running CP/M.

We did not intend to use the microcomputers for serious number crunching at that time, but rather to off-load non-number-crunching tasks from the Novas. Foremost among these tasks was word processing; it was surprising how much time the preparation of scientific papers was taking on the Novas. The benefits of the off-loading were immediate. It became possible to run one or both of the Novas with a single ground most of the time; thus, we received nearly the same benefit that we would have gotten from the memory expansion. The Novas had essentially become personal computers. And we could use Microsoft CP/M FORTRAN to do small problems or program development, tasks where speed of execution was not significant, on the Otronas.

The introduction of the IBM PC did not affect us at first. But later, with the availability of the Intel 8087 chip and the introduction of Microsoft FORTRAN-77 for MS-DOS, which generated in-line code for the chip, it became very advantageous to move to MS-DOS machines. We upgraded our Otronas to their dual-processor configurations and added some hard disks. Our benchmarks showed the IBM PC with an 8087 chip to run at 10 percent of the speed of the VAX, and the Otronas with their 8086/8087 combinations to run at 12 or 13 percent. (Due to the lack of 8-MHz 8087s, we had to install 5-MHz chips in the Otronas.) The Otronas had a limit of 256K bytes, but with IBM PCs we could go to 640K bytes. The speeds were significantly less than we got with the Novas, but it became very economically attractive to switch our number crunching to IBM PCs or compatibles. The price is right: Today it is possible to get IBM PC XT equivalents in the range of $2000 to $3000, including 640K bytes of RAM and the 8087 chip.

Due to the Novas' memory limitations, any problem that we could do with them, we can now do with XT equivalents. We can trade memory for speed in some instances; we are unlikely to need overlays unless our problems become much larger than they have so far; and accessing large amounts of memory in arrays is essentially now transparent to the user. We can also add additional RAM to be used as disk equivalents, thus speeding up access to large stored tables and cutting down on the waiting time for FORTRAN compilations.

Even the speed deficiency will disappear with time. I was looking forward with keen anticipation to the arrival of the IBM AT with the 80286 and 80287 chips, expecting that the performance for number-crunching problems would rise to 25 percent or more of that of a VAX. Alas! That proved not to be true; benchmark tests have shown that the AT runs at the same speed as the XT for problems that spend most of their time in the 8087 or 80287.

(continued)

Therefore, I invested in a Number Smasher board from Microway for installation in our PC XT equivalent instead (actually, it is a PC with a third-party hard disk). This board contains an 8086 and an 8087 running at 9.54 MHz. Benchmarks have shown that this board operates typically at a factor of 2.2 to 2.8 times as fast as the IBM PC, depending on application. In general, in our tests the board ran at approximately 25 percent of the VAX's speed, equivalent to our Nova 3/D in the single-user mode.

Today and Tomorrow

I don't know whether the faster performance of the future will come from chips in the Intel family, retaining PC compatibility, or from chip families from other manufacturers. Some people at the Center for Astrophysics are enthusiastic at the prospect of the Motorola 68000 series with either the Weitek or the Motorola numeric coprocessors, which are predicted to outperform the VAX.

We are now using PC XT equivalents for most of our work, and the Novas will be shut down soon. I have transferred the more interesting software to PC floppy disks, and I am bringing up parts of it on the micros as needed for research. All of this should be very helpful to our scientific productivity. ■

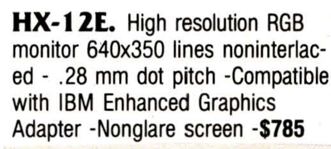
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TWO GENERALIZED FLOATING-POINT REPRESENTATIONS

Dynamic allocation of range and precision fields in FP numbers

Two generalized floating-point representations are described, analyzed, and compared in this article. One is a partitioned representation allowing a trade-off between range and precision. The other is a variable-base representation that achieves a larger range but has fixed accuracy.

Floating-point (FP) representations have not changed much since they were first introduced in the early 1950s. The common floating-point representation consists of a fixed-point fraction F that determines the accuracy (the significant digits) of the number and an exponent E that determines the range of the number. The number is defined as $F\times 2^E$ or, more generally, $F\times B^E$, for some base B. If the signed exponent E is e bits long, it uses an excess B^E representation (a format in which the highest bit designates the sign of the exponent). This, combined with an $S\ E\ F$ format (where S is the sign of the floating-point number), makes it possible to compare floating-point numbers

sign of the exponent for zero negative to preserve the compatibility with integer format. These two features are useful and should, in my opinion, be preserved in any modification or generalization of floating-point representations.

In the past, alternative floating-point representations were not practical because of the complex hardware necessary. Today, however, it is not only possible but practical to design and build a support device to handle floating-point numbers in formats other than $S\ E\ F$. Such a device should be able to

- Accept two floating-point numbers, compare them, or perform any of the four arithmetic operations on them
- Accept one floating-point number and normalize it (set E to the value that accommodates the maximum number of significant figures for F), convert it to integer, or test it for overflow/underflow (if those values exist in the representation used)
- Accept an integer and convert it to a normalized floating-point number

Another way of implementing the design I will propose here is by microprogramming it. Microprogramming is being used more and more, even on large, fast machines.

PARTITIONED FLOATING-POINT REPRESENTATION

Morris has suggested a three-field floating-point format $G\ E\ F$ in which the rest of the number into an e-bit signed exponent and an f-bit signed fraction. This format is flexible, achieving a trade-off between range (the range of values of 2^E) and accuracy (which is determined by the length f of the fraction). However, it has the following drawbacks:

- When G is small ($G<4$), the G field itself uses less than 3 bits. The unused bits could, in principle, be used to increase the effective size of the exponent E, thus increasing the range.
- The exponent ranges for different values of G overlap. Thus the two numbers 010 011 $x \ldots x$ ($G=2$, $E=3$) and 011 0011 $x \ldots x$ ($G=3$, $E=4$) have the same exponent. To achieve a unique representation (important for floating-point comparisons), the exponent has to be normalized by shifting it to the left and decreasing G.
- The sign of the entire number is part of the F field and, therefore, is not the most significant bit of the floating-point number. This complicates comparisons again since, when comparing $G_1\ E_1\ F_1$ and $G_2\ E_2\ F_2$, verifying that $G_1>G_2$ and $E_1>E_3$ does not guarantee that the first number is the greater of the two. Every comparison must include $F_1\ F_2$, and a simple bit-by-bit comparison from left to right (integer comparison) would not work.

- A hidden bit is not used.

The modification proposed here eliminates all these drawbacks except the first one. The proposed format is $S\, S_e\, G\, E\, F$, where S is the sign of the fraction, and S_e is the exponent sign (using a sign convention of 0 for negative and 1 for nonnegative exponents). G is a g-bit field defining the length e of the exponent as $e=G+1$. E is the two's-complement exponent field, and the effective value of the exponent is defined as $E+(2^e-2)$ when $S_e=1$ (nonnegative exponents), and $E-(2^e-2)$ when $S_e=0$ (negative exponents). F is a two's-complement, normalized-fraction field, using a hidden bit. The advantages are

- Since $e=G+1$, the effective value of the exponent is determined by both G and E.
- This definition removes the overlapping in ranges of the exponent for different values of G. For example, $G=1$ implies $e=G+1=2$. Thus e is a 2-bit field ranging in value from -4 to 3. The effective value of the exponent is thus $E+(2^e-2)$ = $(0{:}3)+(2^2-2)$ = $2{:}5$ for nonnegative exponents and $E-(2^e-2)$ = $(-4{:}1)-(2^2-2)$ = $-6{:}-3$ for negative exponents.

These ranges do not overlap with the ranges for $G=0$ or $G=2$ (see table 3). In general, a given e results in the two ranges $-(2^{e+1}-2){:}-(2^e-1)$ for negative exponents and $(2^e-2){:}(2^{e+1}-3)$ for nonnegative ones.
- The fraction F is $n-e-5$ = $n-G-6$

(continued)

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Table 1: *Ranges of floating-point number representations on some computers.*

Computer	n	Approximate range
PDP-11	32 or 64	$10^{-38.6}$ $10^{38.2}$
IBM 7000 series	36	$10^{-38.6}$ $10^{38.2}$
IBM 360, 370	32 or 64	$10^{-78.3}$ $10^{75.9}$
CDC Cyber	60	10^{-308} 10^{308}
Cray-1	64	10^{-2467} 10^{2467}

Table 2: *Representations of some floating-point numbers in the proposed system.*

S	S_e	G	E	Value	Notes
0	1	000	1	$2^{-1}\times 2^1=1$	1
0	1	001	00	$2^{-1}\times 2^2=2$	
0	1	001	01	$2^{-1}\times 2^3=4$	
0	1	010	000	$2^{-1}\times 2^6=32$	
0	0	000	0	$2^{-1}\times 2^{-2}=0.125$	2
0	0	000	1	$2^{-1}\times 2^{-1}=0.25$	2

S	S_e	G	E	Value	Notes
0	0	001	00	$2^{-1}\times 2^{-6}$	2
0	0	001	01	$2^{-1}\times 2^{-5}$	2
1	1	000	0	$-2^{-1}\times 2^0$	3
1	1	000	1	$-2^{-1}\times 2^1$	3
1	0	000	0	$-2^{-1}\times 2^{-2}$	2,3
1	0	000	1	$-2^{-1}\times 2^{-1}$	2,3

Notes:
1. The fraction F in all the examples is all zeros and, therefore, is equal to 0.5
2. Negative exponent
3. Negative fraction

Table 3: *Ranges for Morris and for the proposed system with different values of the G field.*

G	e	E (Morris)	$\bar{E}-(2^e-2)$	$E+(2^e-2)$
0	1	−2:1	−2:−1	0:1
1	2	−4:3	−6:−3	2:5
2	3	−8:7	−14:−7	6:13
3	4	−16:15	−30:−15	14:29
4	5	−32:31	−62:−31	30:61
5	6	−64:63	−126:−63	62:125
6	7	−128:127	−254:−127	126:253
7	8	−256:255	−510:−255	254:509

THE DISTRIBUTION OF LEADING DIGITS

In base B, a normalized fraction has a leading digit in the range 1 to $B-1$. One might think that those values occur with equal probability. However, it was observed long ago that this is not the case. In 1881, the American astronomer Simon Newcomb noticed that the beginning pages of books of logarithms were the most worn. He interpreted this as an indication that people were looking up more logarithms of numbers starting with 1 than any other number. Consequently, he concluded that numbers starting with 1 were used more than other numbers. Knuth (see reference 3) brings detailed arguments supporting the claim that the leading digit of a floating-point fraction is logarithmically distributed. The probability of the digit being i is $p_i = \log_B(1+1/i) = \log_2(1+1/i)/\log_2(B) = \log_2(1+1/i)/b$. Raimi's article (see reference 4) gives a comprehensive review of literature on the logarithmic law.

The worst case of normalization is where the binary representation of the leading digit has $b-1$ leading zeros. This only occurs when the digit is equal to 1, and the probability of that case is $p_1 = \log_2 2/b = 1/b$.

The next worst case, where the leading digit has $b-2$ zeros, occurs when it is equal to 2 or to 3. The probability for that happening is $p_2+p_3 = [\log_2(3/2) + \log_2(4/3)]/b = (\log_2 4 - \log_2 2)/b = 1/b$.

In the general case, the leading digit has k zeros and can have values

$$0\ldots010\ldots00 = 2^{b-k-1}$$
$$0\ldots010\ldots10 = 2^{b-k-1} + 2$$
$$0\ldots011\ldots11 = 2^{b-k-1} + (2^{b-k-1}-1) = 2^{b-k}-1$$

Defining $q = 2^{b-k-1}$, the leading digit takes values $q, q+1, \ldots, 2q-1$.

The probability of such a case is

$$[\log_2(1+\frac{1}{q}) + \log_2(1+\frac{1}{q+1}) + \ldots + \log_2(1+\frac{1}{2q+1})]/b = [\log_2(\frac{q+1}{q}) + \log_2(\frac{q+2}{q+1}) + \ldots + \log_2(\frac{2q}{2q-1})]/b$$
$$= [\log_2(2q) - \log_2(q)]/b = 1/b$$

The probability does not depend on k. All probabilities for the location of the first nonzero bit are thus equal and have the value $1/b$. The average number of leading zero bits is therefore the straight average $(b-1)/2 = (\log_2 B - 1)/2$.

It is interesting to note that, assuming uniform distribution of the leading digit, the probability of having k leading zeros in the binary representation of the leading digit depends on k. There are 2^{b-k-1} different numbers of the form

```
┌────── b ─┐
0...01x...x
└─ k ┘
```

each occurring with probability $1/(B-1)$. The probability of having k leading zeros is thus $2^{b-k-1}/(B-1)$.

The average number of leading zeros in the case of uniform distribution is therefore

$$\sum_{k=0}^{b-1} k \times p_k = \frac{2^{b-1}}{b-1}\sum_{k=0}^{b-1} k \times 2^{-k} = \frac{2^{b-1}}{b-1}(2 - \frac{b+1}{2^{b-1}}) = 1 - \frac{\log_2 B}{b-1}$$

Figure A shows the average number of leading zeros as a function of the base B for both the uniform and the logarithmic distributions.

In the case of the uniform distribution, that average asymptotically approaches 1. This means that at most 1 bit is "lost" when a floating-point fraction is normalized, regardless of the base B used.

If one believes in logarithmic distribution, however, then the result is that the average number of bits lost after normalization is proportional to $b = \log_2 B$.

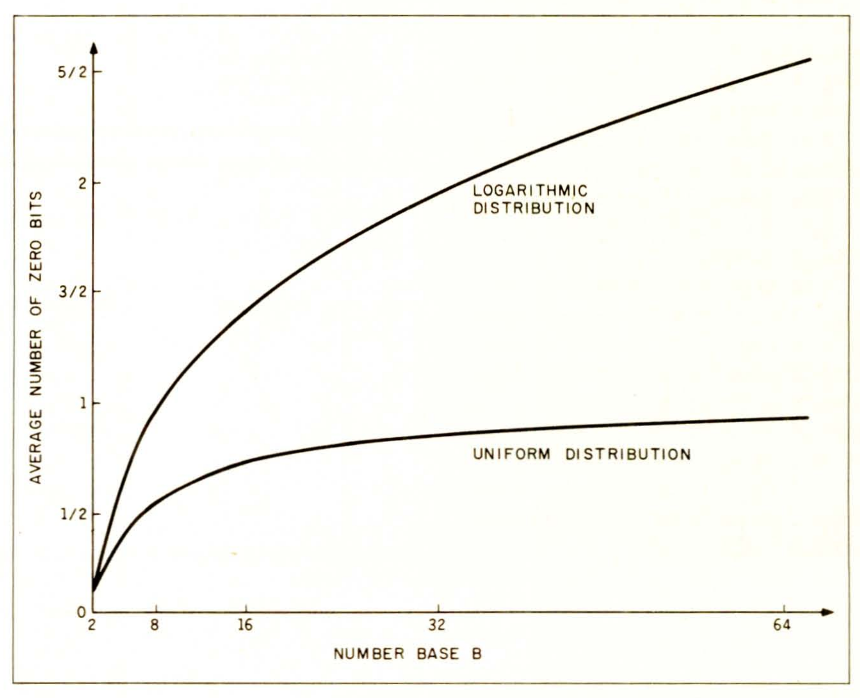


Figure A: *The average number of leading zero bits in the fixed-point fraction assuming (a) uniform distribution of base B digits, and (b) logarithmic distribution of base B digits.*

bits long. Since the fraction is normalized and a hidden bit is used, the effective length of the fraction is $n-G-5$ bits. The smallest fraction is always 0.5 and the largest one is $1-2^{-[n-G-5]}$. Since the extreme values of the exponent occur when $G=7$, the largest floating-point value possible in this representation is $(1-2^{-[n-12]})\times 2^{509} \cong 10^{153.3}$ and the smallest positive value is $2^{-1}\times 2^{-510} \cong 10^{-153.9}$. The range of negative values is similar. Table 1 gives the floating-point ranges for some existing computers.

Floating-point numbers on the Cray-1 computer far exceed the range that can be achieved in the proposed representation with $g=3$. This suggests that large, scientific machines use a 4-bit G field. For $g=4$, the maximum value of G is 15; thus $e=16$, the exponent range is -131070 to 131069, and the floating-point extreme values are $(1-2^{-[n-20]})\times 2^{131069} \cong 10^{39456}$ and $2^{-1}\times 2^{-131070} \cong 10^{-39456}$.

- Since both E and F are two's-complement numbers, comparisons can be done bit by bit from left to right (integer comparisons). Table 2 lists some floating-point values to illustrate this point.

Representation Error

The maximum error in a floating-point number is half of the least significant bit of the fraction or

$$\frac{1}{2}2^{-f}$$

If the floating-point number $\bar{x}$ represents the real number x, then the relative error of the representation is

$$\frac{|x-\bar{x}|}{x}$$

Since $|x-\bar{x}| \leq \frac{1}{2}2^{-f}\times 2^{exp}$

we have $\frac{|x-\bar{x}|}{\bar{x}} \leq \frac{\frac{1}{2}2^{-f}\times 2^{exp}}{\bar{x}} = \frac{\frac{1}{2}2^{-f}\times 2^{exp}}{F\times 2^{exp}}$

$$= \frac{\frac{1}{2}2^{-f}}{F} \leq \frac{\frac{1}{2}2^{-f}}{\frac{1}{2}} = 2^{-f}$$

The conclusion, therefore, is that incrementing G by 1 cuts the relative error in half (by decreasing f) while doubling the range (table 3).

Variable-Base Floating-Point Representation

The definition of a floating-point value is $F\times B^E$ where the base B is usually 2. To explore the possibilities of different bases, we can again use a floating-point format with fields S, S_e, G, E, F and define the base B as $B=2^{G+1}$. The G field now determines the base B and not the exponent size. The above definition allows for bases that are powers of 2, from 2 to 256. There is little practical need, if any, for bases such as 8, 32, or 64, and I will show that such a format is not as flexible as the one previously mentioned.

The main advantage of such a design is large range. The largest base is $B=2^{7+1}=256$, yielding a floating-point number in the range of 256^{-2^e} to 256^{2^e-1}, where e is the length of exponent field E.

Effect of Base Selection on Range and Accuracy

In examining the effects of base selection, let us revert to the S E F form of floating-point representation. The problems associated with other bases are independent of the floating-point format, so we will allow ourselves the luxury of using the simplest representation. Selecting a base greater than 2 affects the floating-point number in two ways. It increases the range from 2^{2^e-1} to B^{2^e-1}. However, if one wants to maintain the same range, the exponent field can be shortened to e' bits where $2^{2^e-1}=B^{2^{e'}-1}$. Defining $b=\log_2 B$, this implies $2^e-1=(2^{e'}-1)\log_2 B=(2^{e'}-1)b$ and the reduction in exponent size is $e-e'=\log_2 b$ bits. This gain of $\log_2 b$ bits can be added to the fraction to increase the accuracy of the floating-point number.

Normalizing a floating-point number with base B is done by decrementing E by 1 and shifting F to the left b positions, repeating until the leftmost b bits of the fraction are nonzero. Up to $b-1$ zero bits may thus be left unused in the fraction and, on the

(continued)

average, $(b-1)/2$ zero bits will be left unused (see text box on page 164). This, added to the fact that a hidden bit can no longer be used, decreases the effective length of the fraction by bits to the effective length of the fraction. Since this quantity is always negative, accuracy is, in fact, decreased.

The main advantage of using a base floating-point addition (for more information, see reference 2).

CONCLUSIONS

The range and accuracy of floating-

BY JOHN FIGUERAS

TURBO PASCAL DRIVES THE MOUSE

A handy procedure to interface the Microsoft Mouse with Pascal

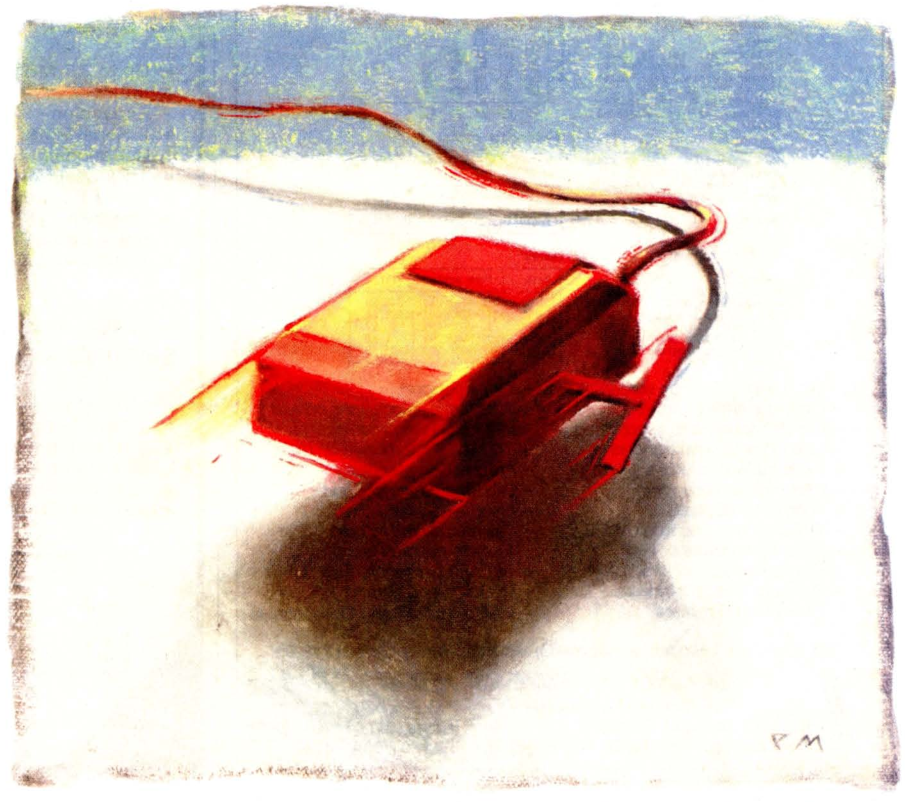
Two Turbo Pascal procedures for accessing the MS-DOS functions and MS-DOS interrupts, MsDOS and Intr, have simplified the task of interfacing the Microsoft Mouse with Pascal. It would have been much more onerous with expensive "full-scale" compilers. The two procedures are not well documented in the Turbo manual, but two .DOC files on the Turbo (version 2) disk, INTRPTCL and DOSFCALL, give examples of their use. Documentation for Intr is considerably improved in version 3.0 of Turbo Pascal, but not for MsDOS. This information, combined with that provided in the Microsoft Mouse manual (*Microsoft Mouse Installation and Operation Manual*, Microsoft Corporation, 1983), was adequate to devise simple Turbo Pascal routines that accomplish the same actions as the BASIC-callable mouse routines supplied by Microsoft.

Interrupt calls in machine language resemble ordinary procedure calls in higher-level languages. Certain values must be placed in the 8088/8086 registers, and an interrupt procedure INT calls the desired procedure with a suitable code. The mouse uses INT 51 (or INT 33 hexadecimal), which with proper values in the registers provide particular Mouse functions. This is similar to passing a parameter to a function in Pascal or other higher-level languages. To program the mouse, the Microsoft Mouse manual requires the passing of the parameters M1%, M2%, M3%, and M4% to 8088/86 registers ax, bx, cx, and dx, respectively, before issuing the INT 51. BASIC ordinarily uses CALL MOUSE (M1%,M2%,M3%,M4%). For example, if I want function number 1 to show the cursor in BASIC, I would set M1% to 1 and issue a CALL MOUSE (M1%, M2%, M3%,M4%); in machine language, I would load the value 1 into register ax and call INT 51.

Turbo Pascal's function Intr (P1, P2) takes two parameters. The first parameter, P1, selects the required interrupt, INT (decimal 51 or 33 hexadecimal for

(continued)

Dr. John Figueras was a research chemist with Eastman Kodak for thirty years. He has a Ph.D. in organic chemistry from the University of Illinois. Now retired, he is a part-time instructor of computer science at State University of New York at Geneseo. He can be reached at 65 Steele Rd., Victor, NY 14564.



ILLUSTRATED BY PAUL MOCK

the mouse); the second parameter, P2, is a Pascal variable of record type that references all of the registers and flags in the 8088/86 microprocessor. In listing 1, this record variable is called recpack and is given the type regset, which comprises the registers introduced above. To access a given mouse function out of Turbo Pascal, therefore, you must load suitable values of the mouse parameters into the fields of the record variable and then pass this record to the function Intr. Values are inserted into the record recpack using either the Pascal with construct or qualified labels (dot notation). Listing 1, MOUSE.PAS, contains the Pascal equivalents for seven mouse functions (see table 1). [*Editor's note: Listings 1 and 2 are available for downloading from BYTEnet Listings, (617) 861-9774.*]

Table 1: *Using listing 1, you can implement the functions below, listed according to their Microsoft function number, Pascal name, and action. If you need them, you should have no trouble implementing the other nine functions discussed in the Microsoft Mouse manual.*

0	mstatus	initialize mouse
1	mshow	display mouse cursor
2	mhide	hide mouse cursor
3	mpos	get mouse position; return coordinates
4	mput	put the mouse at designated coordinates
8	mvlimit	limit mouse vertical position
9	mshape	assign a shape to the mouse cursor

The program MTRIAL (see listing 2) is a simple example of mouse programming in Pascal. The program uses the graphics routines supplied in version 2 of Turbo Pascal. It puts a box-shaped mouse cursor on the high-resolution screen and uses two accesses to draw a line on the screen: the first with the left button and the second with the right button. A repeat . . . until loop monitors the mouse. The loop keeps an eye on the status of the mouse button reported in the variable mbt, which is returned by the procedure mpos. When mbt has the correct value, mpos returns the coordinates of the mouse cursor at the time that the button was pushed.

Notice that whenever the procedure

(continued)

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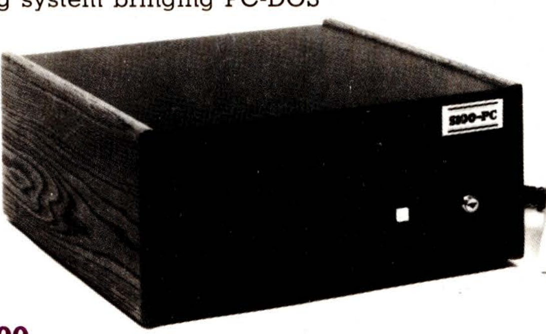
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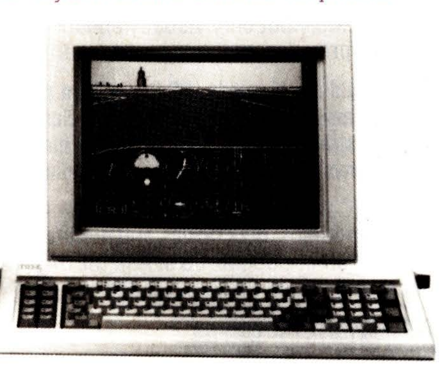
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Inquiry 222

Listing 1: *Turbo Pascal mouse procedures.*

```
procedure mshape(xhot, yhot : integer; var cursor : curarray);
{ xhot and yhot pixel designations for the cursor hot spot.
  cursor is the array containing the cursor shape. curarray
  is array type defined as ARRAY[0..31] OF INTEGER }

type
  regset = record
             ax,bx,cx,dx,bp,di,si,ds,es,flags : integer
           end;
var recpack : regset;

begin
  with recpack do
  begin
     ax := 9;
     bx := xhot;
     cx := yhot;
     dx := Ofs(cursor[0]);
     es := Seg(cursor[0])
  end;
  intr($33, recpack)
end;

procedure mstatus(var mstat, nbuttons : integer);
{ returns mouse status and resets mouse parameters.
  mstat=0 if mouse is not installed, -1 otherwise.
  nbuttons is number of buttons enabled, =2 }

type
  regset = record
             ax,bx,cx,dx,bp,di,si,ds,es,flags : integer
           end;
var recpack : regset;

begin
  recpack.ax := 0;
  intr($33, recpack);
  with recpack do
  begin
     mstat := ax;
     nbuttons := bx
  end
end;

procedure mshow;
{ show mouse cursor }

type
  regset = record
             ax,bx,cx,dx,bp,di,si,ds,es,flags : integer
           end;
var recpack : regset;

begin
  recpack.ax := 1;
  intr($33, recpack)
end;

procedure mhide;
{ hide mouse cursor }

type
  regset = record
```

(continued)



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Inquiry 217

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```
            ax,bx,cx,dx,bp,di,si,ds,es,flags : integer
        end;
var recpack : regset;

begin
  recpack.ax := 2;
  intr($33, recpack)
end;

procedure mpos(var mbt, mx, my : integer);
{ returns position of mouse, coordinates mx,my.
  if mbt=1, left button was pressed
  if mbt=2, right button was pressed
  if mbt=3, both buttons were pressed }

type
  regset = record
            ax,bx,cx,dx,bp,di,si,ds,es,flags : integer
        end;
var recpack : regset;

begin
  recpack.ax := 3;
  intr($33, recpack);
  with recpack do
  begin
     mbt := bx;
     mx := cx;
     my := dx
  end
end;

procedure mput(mx,my : integer);
{ put the mouse cursor at coordinates mx,my.
  legal values must be supplied }

type
  regset = record
            ax,bx,cx,dx,bp,di,si,ds,es,flags : integer
        end;
var recpack : regset;

begin
  recpack.ax := 4;
  recpack.cx := mx;
  recpack.dx := my;
  intr($33, recpack)
end;

procedure mvlimit(minpos, maxpos : integer);
{ set min and max vertical limits for cursor positions }

type
  regset = record
       ax,bx,cx,dx,bp,di,si,ds,es,flags : integer
  end;
var recpack : regset;

begin
  recpack.ax := 8;
  recpack.cx := minpos;
  recpack.dx := maxpos;
  intr($33, recpack)
end;
```

(continued)

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Inquiry 255

Listing 2: A *demonstration of mouse programming in Pascal.* {$I MOUSE.PAS} *is a compiler directive to bring the procedures in listing 1 into a program for implementation.*

```
program mtrial;
{ demonstration program. get two points with the mouse and
  connect them with a line }

type
      curarray = array[0..31] of INTEGER;

var
      cursor : curarray;
      i,nbut,mx,my,mbt,x,y : integer;
{$I MOUSE.PAS }

procedure bdraw;
begin
      gotoxy(1,2);
      write('Use left button for first point, right button for second point.');
      mshow;
      repeat
      mpos(mbt,x,y)
      until mbt=1;
      mhide;
      plot(x,y,1);
      mshow;
      repeat
        mpos(mbt,mx,my)
      until mbt=2;
      mhide;
      draw (x,y,mx,my,1);
end;

begin                                  {MTRIAL main line}
      for i := 0 to 3 do               {load cursor image in hexadecimal}
      cursor[i] := $FFFF;              {these values could be set up as typed
                                       constants}
      cursor[4] := $F00F;
      for i := 5 to 10 do
        cursor[i] := $F7EF;
      cursor[11] := $F00F;
      for i := 12 to 15 do
        cursor[i] := $FFFF;
      for i := 16 to 19 do
        cursor[i] := $0000;
      cursor[20] := $0FF0;
      for i := 21 to 26 do
        cursor[i] := $0810;
      cursor[27] := $0FF0;
      for i := 28 to 31 do
        cursor[i] := $0000;
      HiRes;
      HiResColor(10);                  {set color green}
      mstatus(i,nbut);                 {initialize mouse}
      mshape(8,8,cursor);              {set cursor shape}
      mshow;                           {display cursor}
      bdraw                            {get 2 points and draw line}
end.
```

bdraw plots or draws, a call to the procedure mhide turns off the mouse cursor. With the Microsoft Mouse installed, the cursor will tend to interfere with plotting if the cursor is on when plotting. After the plotting has finished, the cursor can be moved freely over the plot without disrupting it. Therefore, hide the cursor during the plotting.

In addition, pay attention to the setting up of the cursor array and the passing of its location to the mouse routine mshape. When the mouse is programmed in BASIC, the screen and cursor masks are set up in a two-dimensional (16 by 2) integer cursor array (see the Microsoft Mouse manual for an example), and the location of this array in memory is passed to the cursor shape function (number 9) as a parameter with the value cursor(0,0), where cursor is the name of the cursor array. The Microsoft Mouse manual warns that in machine language, the masks that describe the cursor shape must be assigned to two contiguous arrays in memory, and the address of the first one goes in register dx. Therefore, in the Pascal program, the screen mask is placed in a single-dimensioned array, and the cursor mask is placed in the same array, directly following the first mask. This ensures that the two masks occur in contiguous arrays. In Turbo Pascal, the function Ofs returns the starting address (offset) of the cursor array required in dx, and the Turbo function Seg returns the segment part of that address.

To use the Mouse from Turbo Pascal, load the mouse files onto the Turbo disk and include Microsoft's MOUSE.COM in a boot-up AUTOEXEC.BAT file, or MOUSE.SYS in a CONFIG.SYS file. Once these routines are loaded at boot-up, Turbo Pascal can access all mouse functions. The Pascal mouse procedures are stored as ASCII (American Standard Code for Information Interchange) source code in a file MOUSE.PAS (see listing 1); the compiler directive {$I MOUSE.PAS} brings the procedures into a program for implementation. ■

Inquiry 410

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BY HERBERT STEIN

IBM COMPATIBILITY FOR THE NEC APC III

This patch lets the APC III *run* IBM *software*

When NEC announced its new APC III, it was difficult not to be impressed by the machine. The microprocessor, a 16-bit 8086 running at 8 MHz, has the support of two graphics controllers whose customized hardware environment works with a variety of screen formats. These graphics controllers let you create the best graphics I have seen on a microcomputer. (See "The NEC APC III" by John D. Unger, March BYTE, page 256, for a more in-depth look at the system.)

The problem with the APC III is that it is not compatible with the IBM Personal Computer (PC), although its disk format is. Aside from getting the APC III to read IBM PC files from IBM PC-formatted disks, I had little success getting it to do anything else. The system seemed to bomb out immediately after loading a program. According to the system manuals, NEC, not willing to produce another IBM PC clone, decided to give its APC all of the IBM PC display features but located the I/O (input/output) drivers (including the screen driver) at slightly different locations. Every call to display a character on the screen ended in an interrupt-return instruction. And, of course, with no driver there was no screen output.

To work out the problem, I started to rearrange interrupt locations. After exploring the APC III's capabilities, I prepared an operating system patch (see listing 1) that gives some degree of IBM PC compatibility.

With this patch I ran standard IBM software (including Turbo Pascal [PC-DOS version 2.00], the Sanyo MBC 555 version of WordStar, and version 1.0 of Perfect Writer and of Perfect Speller) on the APC III without any problems. I was unable to use Lotus Development Corporation's 1-2-3.

At first I couldn't run version 3.3 of WordStar because this version writes video data directly to the hardware. However, the following patch will allow WordStar to revert to the more conventional I/O methods it used in the earlier versions, correcting the problem:

```
A> debug ws.com
-e 2aa 00
-e 2b0 00
-e 2b3 00
-w
Writing 5380 bytes (debug
  displays this message)
-q
A>
```

The software executed faster on the APC III than on the IBM PC. I measured Turbo Pascal directly with the Sieve of Eratosthenes benchmark [*Editor's note: Turbo Pascal listings of these benchmarks are available for downloading via* BYTE*net Listings. The telephone number is* (617) 861-9774]. The APC III ran one iteration of the Sieve in 6.2 seconds, while the IBM PC ran it in 12.6 seconds.

MAKING THE INCOMPATIBLE COMPATIBLE

The compatability problem involves more than reshuffling interrupt locations. The screen attributes of the APC III have nothing in common with standard IBM PC attributes. Therefore, the patch also includes an attribute-translation program, which occupies about 200 bytes of memory space.

It is necessary to install the patch in the interrupt table. The table, once set up, won't be overwritten by the operating system or a compiler and provides ample space for operating-system changes because the NEC microcomputer uses only 64 out of 255 interrupt vectors (see figure 1). The memory starting at address 10:0 (all addresses in this article are hexadecimal) up to the MS-DOS buffer area at 40:0 can hold a maximum program of 768 bytes. The tiny compatibility patch fits easily into this memory area.

The run-time module contains two procedures: The first memory segment (Copycode) contains the run-time environment for the screen driver; the second (Transfer) copies the first segment to address 100 and adds interrupt vectors to the NEC in-

(continued)

Herbert Stein (5/22 Hutton Ave., Ferntree Gully, Victoria 3156, Australia) is a member of the computer science staff at Telecom Australia Research Laboratories in Melbourne. His interests include writing computer books and restoring furniture.

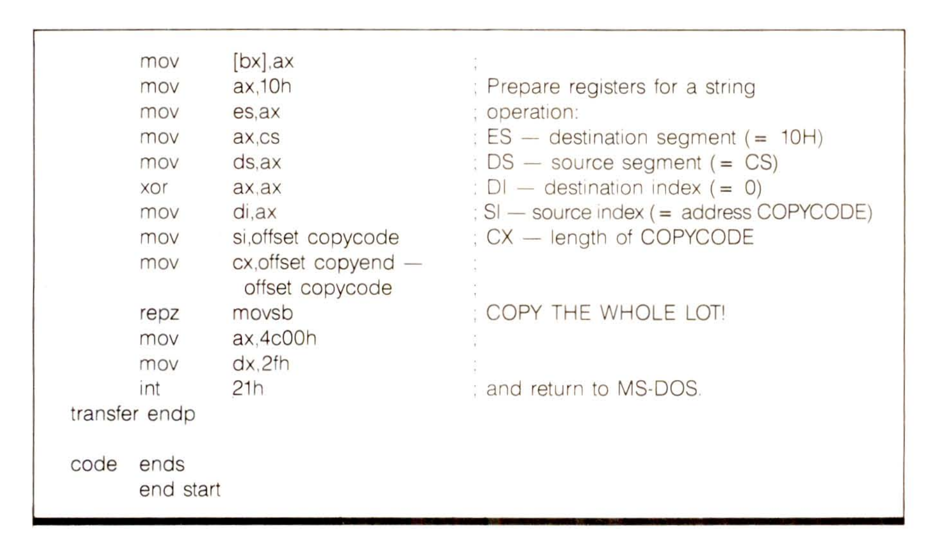
NEC APC III PATCH

Listing 1: *To achieve IBM PC compatibility, this patch overlays the interrupt table of the NEC APC III. The program makes use of undefined interrupt locations and stores an attribute-translation subroutine at address (CS:IP) 10:0. The first part of this program, Copycode, accepts the IBM character attributes and translates them into NEC display standards. The second part of the program, Transfer, patches the interrupt locations to suit the IBM PC keyboard, disk, printer, and video drivers. Besides these connections, Transfer loads the IBM compatibility subroutine and, after the copy operation, returns to MS-DOS.*

```
; ********** Standard NEC APC III BIOS calls won't be affected. ********** ;
;
        assume cs:code
code    segment public 'code'
;
; COPYCODE — NEC APC III patch at address 10H:0H (CS:IP)
;
copycode        proc
        cmp     ah,0                    ; In case an application program sets
        jnz     nomode                  ; a new video mode, the mode number must
        mov     cs:mode,al              ; be stored (CS:MODE) before
        db      0eah                    ; the JMP to the NEC APC III interrupt
        dw      0f70h                   ; subroutine can take place (F800H:0F70H).
        dw      0f800h                  ;
nomode:                                 ; Otherwise, the service requested (passed
        cmp     ah,0eh                  ; in register AH) indicates whether special
        jz      blreg                   ; action is necessary or not. The codes
        cmp     ah,09h                  ; 06H, 07H (scroll page), 09H, 0AH (write
        jz      blreg                   ; character), and 0EH (Teletype) require
        cmp     ah,0ah                  ; patching.
        jz      blreg                   ;
        cmp     ah,6                    ; Both scroll operations pass the display
        jz      bhreg                   ; attribute in register BH. All other
        cmp     ah,7                    ; operations use register BL.
        jz      bhreg                   ;
        db      0eah                    ; All other codes are directly passed
        dw      0f70h                   ; to the video-interrupt subroutine.
        dw      0f800h                  ;
bhreg:                                  ;
        push    bx                      ; In case BH contains the attribute, the
        mov     bl,bh                   ; register is saved and BH copied into BL.
blreg:                                  ; Attributes are available only for
        cmp     byte ptr cs:mode,4      ; text modes (0, 1, 2, 3).
        jc      textmode                ; Text within a graphics mode (> 4)
        mov     byte ptr cs:newattr,1   ; is displayed in one color only!
        jmp     return                  ; **** CURRENT B/W LIMITATION ****
textmode:                               ;
        mov     byte ptr cs:newattr,0   ; Within the text modes, bit 7 of
        test    bl,80h                  ; BL specifies a blink bit, which
        jz      noblink                 ; must be translated into the
        or      byte ptr cs:newattr,2   ; appropriate NEC attribute.
noblink:                                ;
        test    byte ptr cs:mode,1      ; Color modes are treated differently.
        jz      mono                    ; The patch rotates the
        ror     bl,1                    ; RGB information into the highest
        ror     bl,1                    ; NEC attribute positions, clears
        ror     bl,1                    ; remaining bits, and updates the
        and     bl,0e0h                 ; NEC attribute.
        or      byte ptr cs:newattr,bl  ;
        jmp     return                  ;
```

```
mono:                                          ;
        or      byte ptr cs:newattr,80h        ; In monochrome mode, the intensity
                                               ; is initially set to half dim.
        test    bl,8                           ;
        jz      nointens                       ; Full intensity requires a change
        or      byte ptr cs:newattr,0e0h       ; of the preset value.
nointens:                                      ; Having looked after blink and
        and     bl,77h                         ; intensity, the patch can forget
        cmp     bl,0                           ; about these bits.
        jnz     underlin                       ; In case no other bits are set,
        and     byte ptr cs:newattr,1fh        ; the intensity bits are cleared to
        jmp     return                         ; write black on black.
underlin:                                      ;
        cmp     bl,1                           ; If an underline is requested, it
        jnz     stdchar                        ; must be translated into the
        or      byte ptr cs:newattr,8h         ; appropriate NEC code.
        jmp     return                         ;
stdchar:                                       ;
        cmp     bl,8                           ; Because the attributes are set, no
        jc      return                         ; action is required for normal characters,
        cmp     bl,70h                         ;
        jnz     whitwhit                       ; but the reverse attribute (70H)
        or      byte ptr cs:newattr,4          ; requires attention again and must
        jmp     return                         ; be translated to suit the NEC.
whitwhit:                                      ; Whatever else might come along
        or      byte ptr cs:newattr,0e4h       ; is interpreted as writing characters
return:                                        ; white on white.
        cmp     ah,8                           ;
        jnc     newbl                          ; Finally, the services 06H and 07H
        pop     bx                             ; require the new NEC attribute in
        mov     bh,byte ptr cs:newattr         ; register BH.
        jmp     video                          ;
newbl:                                         ; All other services pass the
        mov     bl,byte ptr cs:newattr         ; display attribute in register
video:                                         ; BL.
        db      0eah                           ; (Common NEC video interrupt at
        dw      0f70h                          ; location CS=F800H, IP=0F70H.)
        dw      0f800h                         ;
mode    db      0                              ; Current display mode.
newattr db      0                              ; New attribute.
copyend db      0
copycode        endp
;
; TRANSFER the patch to the address 10H:0H
;
transfer        proc    far
start:
        xor     ax,ax                          ; Start with relocation of interrupt
        mov     ds,ax                          ; addresses.
        mov     ax,34dah                       ; 1. diskette, disk (no connection)
        mov     bx,4ch                         ;
        mov     [bx],ax                        ;
        mov     ax,0a04h                       ; 2. keyboard (NEC 8087 interrupt)
        mov     bx,58h                         ;
        mov     [bx],ax                        ;
        mov     ax,2c5ch                       ; 3. printer (no connection)
        mov     bx,5ch                         ;
        mov     [bx],ax                        ;
        mov     ax,0                           ; 4. video interrupt (no connection)
        mov     bx,40h                         ;
        mov     [bx],ax                        ;
        mov     ax,10h                         ;
        mov     bx,42h                         ;
```

(continued)



```
        mov     [bx],ax                   ;
        mov     ax,10h                    ; Prepare registers for a string
        mov     es,ax                     ; operation:
        mov     ax,cs                     ; ES — destination segment (= 10H)
        mov     ds,ax                     ; DS — source segment (= CS)
        xor     ax,ax                     ; DI — destination index (= 0)
        mov     di,ax                     ; SI — source index (= address COPYCODE)
        mov     si,offset copycode        ; CX — length of COPYCODE
        mov     cx,offset copyend —       ;
                  offset copycode         ;
        repz    movsb                     ; COPY THE WHOLE LOT!
        mov     ax,4c00h                  ;
        mov     dx,2fh                    ;
        int     21h                       ; and return to MS-DOS.
transfer endp

code    ends
        end start
```

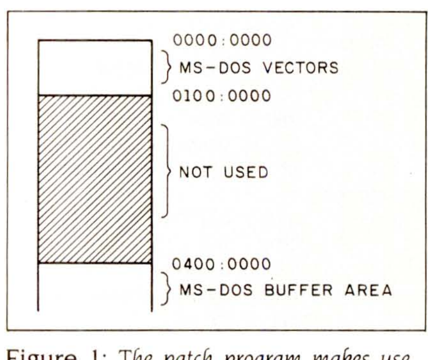


Figure 1: *The patch program makes use of undefined interrupt locations and stores an attribute-translation subroutine at address* 0010:0000 *(all addresses in the figures are in hexadecimal notation).*

LEVEL	NEC APC III	IBM PC	
0	DIVIDE BY ZERO		
1	SINGLE STEP		
2	NMI		
3	BREAKPOINT		
4	ARITHMETIC OVERFLOW		
5	CRT DUMP		
6	RESERVED		
7	RESERVED		
8	TIMER INTERRUPT		
9	KEYBOARD INTERRUPT		
A	EOI	RESERVED	
B	EOI	COMMUNICATIONS	
C	RS-232	COMMUNICATIONS	
D	EOI	DISK	
E	EOI	DISKETTE	
F	EOI	PRINTER	
10	EOI	CRT-I/O	NEC 19
11	EOI	EQUIPMENT CHECK	
12	DISKETTE	MEMORY SIZE	
13	EOI	DISK I/O	NEC 1D
14	EOI	RS-232C I/O	
15	EOI	CASSETTE	
16	8087-INTERRUPT	KEYBOARD I/O	NEC 18
17	EOI	PRINTER I/O	NEC 1B
18	KEYBOARD I/O	RESIDENT BASIC	
19	CRT I/O	BOOTSTRAP	
1A	RS-232C I/O	TIME OF DAY	
1B	PRINTER I/O	KEYBOARD BREAK	
1C	TIMER I/O	TIMER TICK	
1D	DISK I/O	VIDEO INIT	
1E	RESERVED	DISK PARAMETER	EOI-END OF INTERRUPT
1F	RESERVED	VIDEO-GRAPHICS CHAR	
20	MS-DOS INTERRUPTS		

Figure 2: *The interrupt tables of the* NEC APC III *and the* IBM PC. *Note that the* APC III *supports the* 8087 *with the* IBM PC *keyboard-interrupt vector; the patch therefore sacrifices the interface to the* 8087.

terrupt table. [*Editor's note: The source code for the patch is also available for downloading via* BYTE*net Listings*.]

Figure 2 compares the interrupt tables of both NEC APC III and IBM PC and illustrates all of the needed changes. You have to modify the disk, printer, video, and keyboard vectors to obtain any sort of IBM PC compatibility. However, the disk, printer, and video interrupts will be fairly easy to modify because these vectors are not connected to existing interrupt programs. Rather, they address a common end-of-interrupt (EOI) service that can be replaced with an appropriate driver address. Patching the keyboard driver is more difficult because the APC III supports the number-cruncher 8087 with the IBM PC keyboard-interrupt vector. For now, achieving IBM PC compatibility means giving up the interface to the 8087.

Although there is little correlation between the IBM PC and the NEC APC III interrupt vectors, if you replace only the APC III's disk-, printer-, video-, and keyboard-driver addresses, you will be able to execute Turbo Pascal, WordStar, and the Perfect Software series. As I mentioned, the video interrupt requires that the patch translate all the IBM PC display attributes into their NEC equivalents. Therefore, the video-interrupt address, interrupt 10, refers to the patch program Copycode at ad-

(continued)

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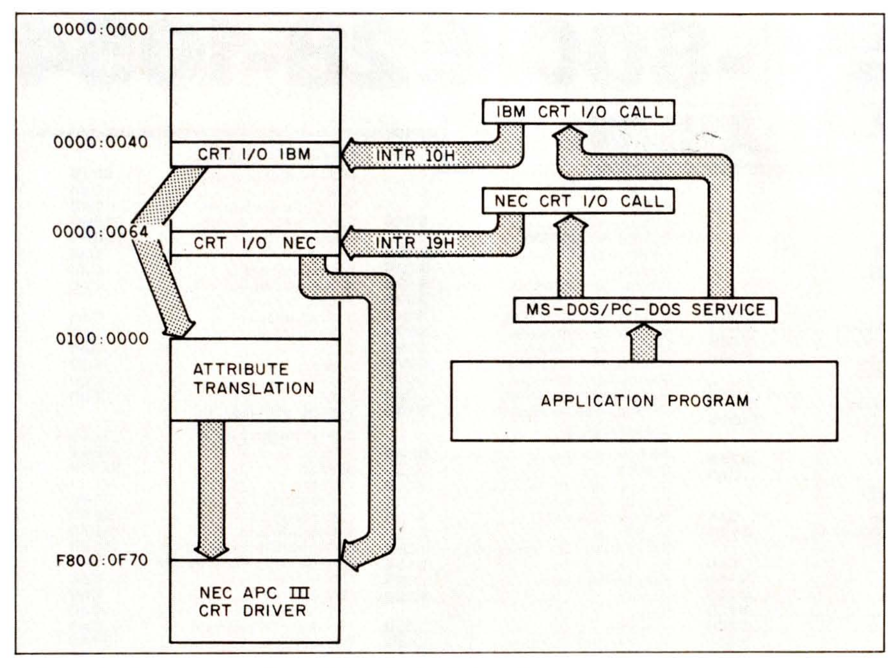


Figure 3: *The program flow of the display I/O calls.*

dress 10:0, which modifies the text attributes and, finally, passes control to the NEC screen driver (see figure 3).

Unfortunately, not all attributes have a matching equivalent because the display philosophy of the NEC microcomputer does not include background colors and is limited to eight foreground colors. To compensate, APC III programmers can use underlining, overlining, and reverse video in all eight colors. Figure 4 summarizes the attributes and the colors or gray shades available.

To modify an IBM PC attribute, the patch program has to recognize the display mode as well as the requested service. Only text modes (modes 0 to 3) and the selected services (06—scroll up screen, 07—scroll down screen, 09—write character and attribute, 0A—write character only, and 0E—write Teletype character) require

(continued)

If a color text mode has been specified at an earlier stage, Copycode cannot make use of the intensity flag or the IBM PC background color.

program interaction. All other requests can be passed directly to the NEC CRT (cathode-ray tube), or display, I/O driver.

If a color text mode has been specified at an earlier stage, the program Copycode cannot make use of the intensity flag or the IBM PC background color. It generates the NEC attribute out of the remaining blink bit and the foreground RGB (red-green-blue) information (see figure 5).

In a monochrome mode, all IBM PC attributes can be displayed without problems. Figure 6 shows that the NEC APC III supports display features like overlining and vertical bars in addition to the IBM PC attributes.

The assembly-code listing provides a more detailed view of the attribute-translation process. Both program segments, Copycode and Transfer, are well documented and should provide sufficient information for future expansion.

You might have a problem with the missing link to the arithmetic coprocessor because the patch program overwrites the 8087 interrupt location. I would not regard this as serious because the 8-MHz version of the coprocessor is hard to obtain (few APC IIIs will come with the chip, and most users will probably find it too expensive). When the price comes down, however, the 8087 will be a must for a graphics environment, especially for rotation, scaling, shearing, and translation of two- and three-dimensional images.

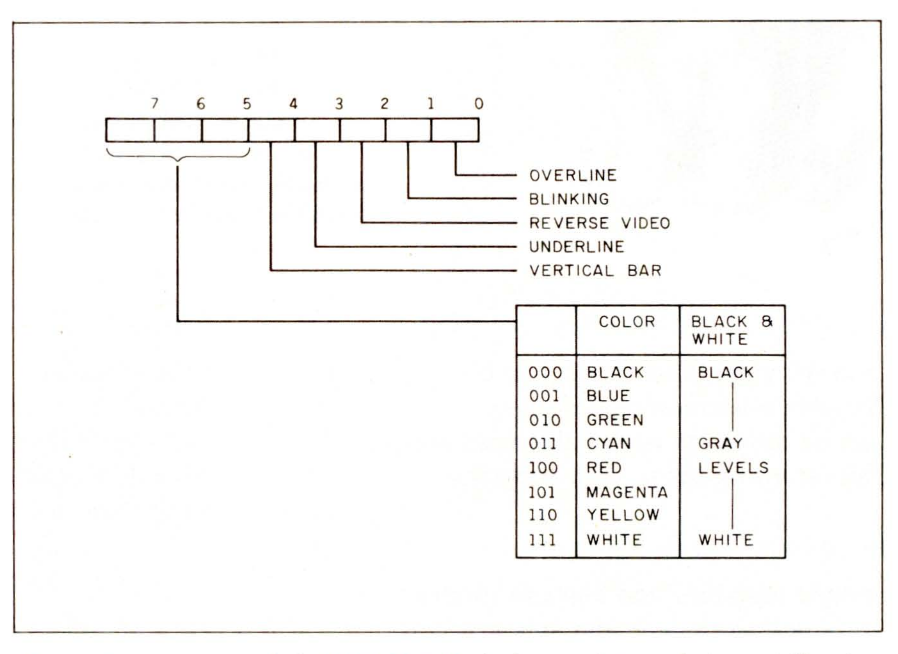


Figure 4: *A summary of the* NEC APC III *display attributes and the available colors and shades of gray.*

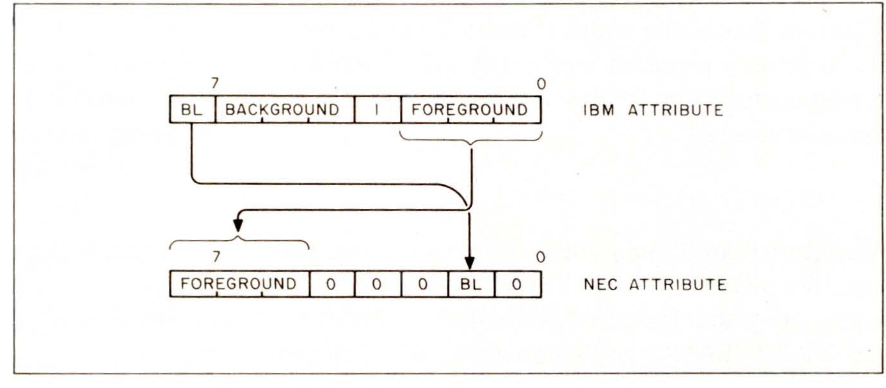


Figure 5: *The translation of the color attributes.* Note that the APC III *cannot make use of the background color or the intensity flag.*

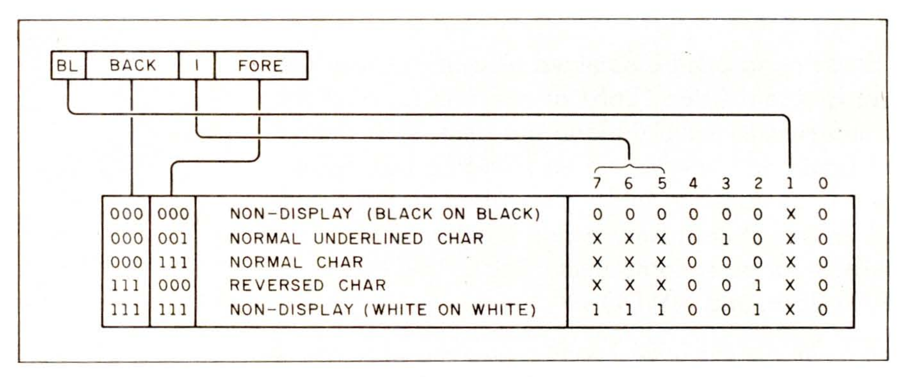


Figure 6: *The translation of the monochrome attributes. In addition to the* IBM PC *attributes, the* APC III *supports additional features like overlining and vertical bars.*

Graphics Enhancements for the NEC APC III

When the patch (see listing 1) executes, the NEC APC III will accept graphics commands and IBM screen configurations without any side effects. To increase speed, replace the Turbo Pascal graphics primitives with specific hardware drivers to handle directly the following interrupt services: draw line, draw rectangle, fill rectangle, and draw circle.

A hard Pascal interface will speed up image generation by about 20 times.

Both graphics controllers (text and graphics) and their customized hardware environment occupy roughly two-thirds of the main board and make the APC III superior to most other low-priced personal computers. The APC III can produce complex drawings or even animated graphics 40 times faster than the IBM PC. And, the APC III makes it possible to scroll quickly through WordStar text.

Another interesting aspect of the APC III's graphics support is the GSX (graphics system extension) kernel. This add-on to the operating system (MS-DOS 2.11) interfaces via interrupts to high-level languages and provides services similar to GKS (graphics kernel system) on a graphics workstation.

The basic system supplies two GSX disks. One contains the GSX kernel and mouse and NEC printer interfaces. The second keeps standard printer/plotter drivers. Unfortunately, NEC doesn't provide information about the GSX interface in the documentation; the company does discuss printers but not the programming interface. If the NEC does support the interface to either the GSX package or the NEC hardware, non-hardware programmers should have no problem writing Pascal programs for animation or complex display applications. Many people working in our lab who were unfamiliar with Turbo Pascal and graphics hardware were able to put together animation programs in an hour or two.

For other graphics possibilities, Digital Research's DR Draw package gives you a menu-driven interface and eases the generation of graphics images. But again, the APC III manual does not explain how to interface the graphics files to a high-level language. Users unsatisfied with DR Draw might use GEM (Digital Research's Graphics Environment Manager), which provides presentation graphics and Macintosh fonts as well as free-form drawing. GEM will use the standard Macintosh-type pull-down menus, icons, and pointing devices. With GEM, the NEC APC III will be able to compete with the more expensive Macintosh computer without special print equipment.

Future Enhancements

With its graphics hardware the APC III will challenge more computers than just the Macintosh or IBM PC. With the addition of communications software, the graphics capabilities of the APC III are sufficient to emulate graphics terminals. The operating system, which even provides an XON/XOFF protocol, will handle most of the communication interface. Standard communication packages are available, but you should evaluate them and, if necessary, change the patch program to suit the new application.

To increase the speed for trigonometric calculations without having to buy a special compiler, you will have to replace the standard keyboard driver of an IBM PC compiler with an additional keyboard-input subroutine. Then you will need to remove the keyboard-vector patch, leaving the 8087 interrupt unchanged. But losing the comfortable built-in keyboard interrupt may be a reasonable sacrifice for much faster (20 to 50 times) and more accurate calculations.

With this optional chip and both graphics coprocessors, the NEC APC III seems to be the fastest low-cost IBM PC clone (with patch implemented, of course) on the market, at least until the next supermicrocomputer comes along. ■

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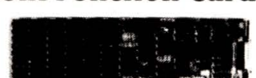
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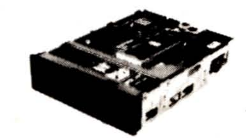
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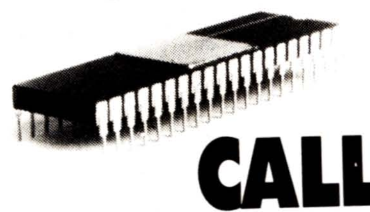
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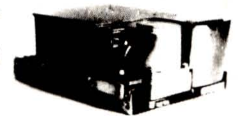


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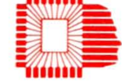
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BUILD A TRAVESTY TREE

BY PETER WAYNER

A tree data structure improves search time for travesty generation

THE TRAVESTY GENERATOR that was presented by Hugh Kenner and Joseph O'Rourke ("A Travesty Generator for Micros," November 1984 BYTE, page 129) works well for taking short initial texts, finding probabilities of various combinations, and generating a random output text. It illustrates the concept simply and uses hardly any memory, but since it checks the whole source text for each and every letter of output, the time that the program takes to finish the task depends mainly on the product of the lengths of the input string and the output string.

If a frequency table could be constructed, the output could be generated in a time that is proportional to the sum of the lengths. The time it takes to build the table would be dependent upon the length of the source, and the time to write the output would depend on the size desired. So, using a frequency table, the time to write 10,000 characters based upon a sample paragraph size of 20,000 characters would take about $10{,}000a + 20{,}000b$ seconds where a and b are constants. The simpler version offered by Kenner and O'Rourke, which depends on the product of the lengths, would take about 10^{8c} seconds, where c is a constant. The linear behavior associated with frequency tables would be very desirable for large runs.

The problem with frequency tables is that they waste so much space. Combinations such as "qz" rarely (if ever) come up in English, but they still require space in the table. The memory that these combinations consume is immense. A paragraph of 1000 characters has at most 997 different combinations of four letters in a row, but a frequency table would take at least 30^4, or 810,000, units to store this.

The best solution to this problem is to abandon the tables and replace them with a forest of 60 data trees. The root of each tree is either a punctuation mark or an upper- or lowercase letter. The branches that are attached to each root are the various combinations of letters that follow in the source string (see figure 1). In a fourth-order run of the program, each branch is four nodes long, and each node contains one combination of four letters that is found in the text. The leaf at the end of the branch contains the number of times the combination is found. Given three letters, a new letter to follow it can be chosen by finding the three letters in the tree and then randomly selecting one of the twigs attached to it.

A TRS-80 Model 100 BASIC program that generates travesty text using the tree data structure described is shown in listing 1. It packs the information in one long, three-integer-wide array, M. The first number of the triplet of integers, M(n,1), stores the letter of the branch in the form of a number that refers to the position of a letter in the string Q$. The second number points to another branch on the same level, and the third points to the next node in the same branch of the tree. The program takes the sample text from an internal file, codes it into matrix T, and then builds the tree. Finally, it writes the output by examining the tree.

Since the Model 100 uses a BASIC interpreter, it runs much slower than Kenner and O'Rourke's Pascal program, but more abstract comparisons

(continued)

Peter C. Wayner is a senior majoring in math at Princeton University. He can be reached at the Department of Mathematics, Princeton University, Princeton, NJ 08544.

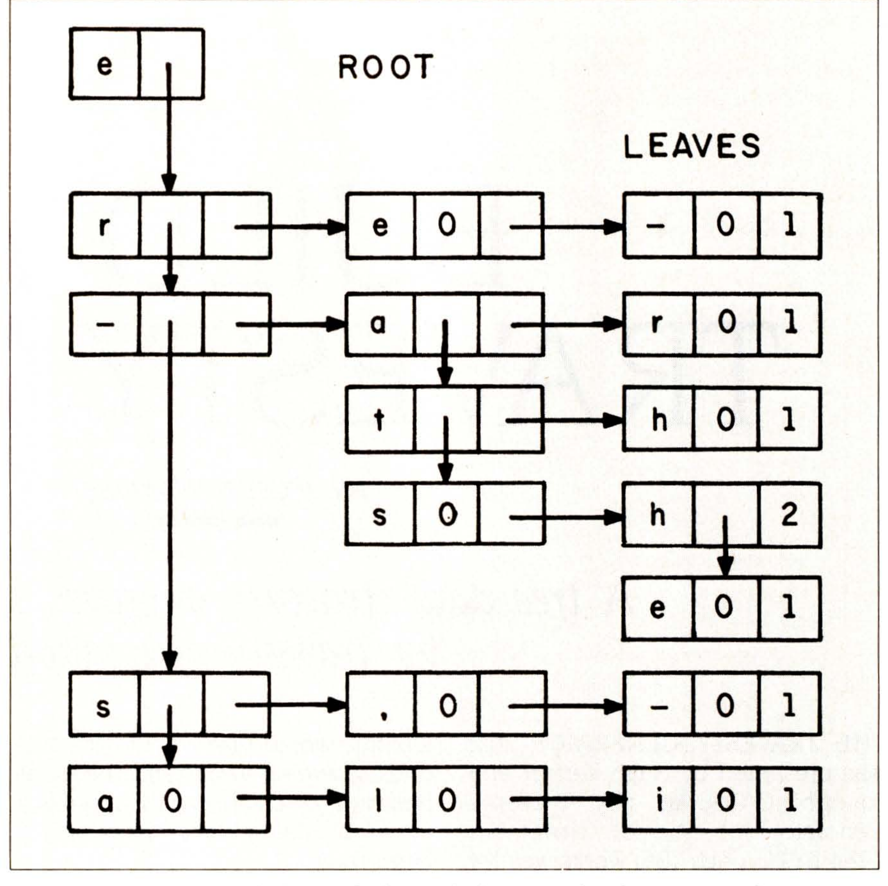


Figure 1: *A diagram of the tree built for the letter "e" by the program when it processes the string "Here are the shoes, the ships, and the sealing wax." Each entry consists of one field that holds the character and two fields that hold pointers. (The root uses only one pointer field.) The last entry on a branch (its "leaf") uses the second pointer field to store frequency.*

We can see from the tree that the only characters that immediately follow "e" are "r," "__," "s," and "a." The string "e__a" is followed only by an "r," and this occurs only once. The string "e__s" is followed by an "h" (occurs two times) and an "e" (occurs only once).

Listing 1: *The TRS-80 Model 100 BASIC program that generates travesty text using the tree data structure described. The source code for this program is available for downloading via* BYTEnet Listings *under the name* TRAV100.BAS. *The telephone number is (617) 861-9774. A version of the program for the* IBM PC *is also available on* BYTEnet *under the name* TRAVTREE.BAS.

```
10 REM A program to build a tree and then generate random text.
20 DEFINT T,M
30 DIM T(700),M(2000,3)
40 L=4
50 N=60
60 FOR X=1 TO N-1
65 M(X,1)=X
70 NEXT X
80 OPEN "ram:print.do" FOR OUTPUT AS 1
85 TIME$="00:00:00"
```

(continued)

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CWSS-785

TRAVESTY TREE

```
90 PRINT #1,"Beginning time:";TIME$
91 REM
92 REM Take the text from an internal file
93 REM and store it in array T.
94 REM This step can be eliminated if the
95 REM letters are processed
96 REM as they are read from the file.
97 REM
100 M=1
110 OPEN "ram:input.do" FOR INPUT AS 2
120 A$=INPUT$(1,2)
130 T(M)=ASC(A$)-64
140 IF T(M)>32 THEN T(M)=T(M)-6
145 REM
146 REM These lines assign the appropriate
147 REM codes to punctuation.
148 REM
150 IF T(M)=-32 THEN T(M)=53
160 IF T(M)=-20 THEN T(M)=54
170 IF T(M)=-18 THEN T(M)=55
172 IF T(M)=-5 THEN T(M)=56
174 IF T(M)=-25 THEN T(M)=57
180 IF T(M)<>0 THEN M=M+1:GOTO 120
182 REM
184 REM Finally a wraparound pad is added just like
186 REM the original Travesty program.
188 REM
190 FOR X=1 TO L
192 T(M)=T(X)
194 M=M+1
196 NEXT X
290 REM
291 REM Now build the tree using matrix M.
292 REM The letter at node n is stored in
293 REM M(n,1), the pointer to equal levels
294 REM is placed in M(n,2), and the pointer
295 REM to the next level down is M(n,3).
296 REM
300 FOR A=1 TO M-L
310 D=1
315 Y=M(T(A),2)
320 IF Y=0 THEN Y=T(A):GOTO 600
400 IF M(Y,1)=T(A+D) THEN 500
410 IF M(Y,2)=0 THEN 600
420 Y=M(Y,2)
430 GOTO 400
500 REM
505 REM If there is a match then look further until a set
506 REM of matches reaches down to the bottom level.
507 REM If not, add a branch.
508 REM
520 D=D+1
530 IF D<L THEN Y=M(Y,3):GOTO 400
540 M(Y,3)=M(Y,3)+1
550 GOTO 999
600 REM
601 REM A subroutine to add a branch.
602 REM
610 P=L-D-1
620 FOR X=0 TO P
630 Z=N+X
640 M(Z,1)=T(A+X+D)
650 M(Z,2)=0
```

(continued)

```
660 M(Z,3)=Z+1
670 NEXT X
680 M(Y,2)=N
690 M(Z,3)=1
700 N=N+L-D
710 GOTO 999
990 REM
992 REM Close the loop and proceed on.
993 REM
999 NEXT A
1000 REM
1001 REM Generate a P-character-long text of order L,
1002 REM by searching the tree of (l-1)-tuples that match.
1004 REM Then choose one randomly.
1005 REM
1050 PRINT #1,"Time to form tree:";TIME$
1060 P=400
1100 PRINT #1,"M=number of seed letters=";M
1110 PRINT #1,"N=number of nodes used=";N
1120 PRINT #1,"L=depth=";L
1130 PRINT #1,"P=size of output=";P
1140 GOTO 1300
1145 REM
1150 REM A short section to print the tree if needed.
1160 REM
1200 FOR X=1 TO N
1210 PRINT #1,USING "####";X;
1220 PRINT #1,USING "###";M(X,1);
1230 PRINT #1,USING "#####";M(X,2);
1240 PRINT #1,USING "#####";M(X,3);
1250 NEXT X
1260 REM
1300 REM Begin the text generation using Q$
1301 REM whose i-th character corresponds
1302 REM with the tree code i.
1303 REM
1310 DIM Q$(60)
1320 Q$="ABCDEFGHIJKLMNOPQRSTUVWXYZ
        abcdefghijklmnopqrstuvwxyz ,.;'"
1330 A=0
1331 REM
1332 REM Use array S for sliding storage of
1333 REM the last l characters printed. Use
1334 REM modulo arithmetic to keep track.
1335 REM
1340 DIM S(L)
1350 X=INT((M-L)*RND(1))
1360 FOR Z=1 TO L
1370 S(Z)=T(X+Z)
1380 NEXT Z
1390 REM
1391 REM A letter has been found. Go down
1392 REM one level on the tree.
1393 REM
1400 REM
1405 Y=M(S((A MOD L)+1),2)
1410 FOR X=1 TO L-2
1420 IF M(Y,1)=S(((A+X) MOD L) + 1) THEN 1450
1430 Y=M(Y,2)
1440 GOTO 1420
1450 Y=M(Y,3)
1460 NEXT X
1500 IF M(Y,2)=0 THEN 1570
```

(continued)

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```
1510 Y1=Y
1515 Z=0
1520 Z=Z+M(Y,3)
1530 Y=M(Y,2)
1535 IF Y>0 THEN 1520
1540 Z=INT(Z*RND(1)+1)
1545 Z=Z-M(Y1,3)
1550 IF Z>0 THEN Y1=M(Y1,2):GOTO 1545
1560 Y=Y1
1565 REM
1566 REM A letter is found. Print it and add it
1567 REM to the list.
1568 REM
1570 Z=M(Y,1)
1574 S(((A+L-1) MOD L)+1)=Z
1580 PRINT #1,MID$(Q$,Z,1);
1590 A=A+1
1600 IF A<P THEN 1400
1610 PRINT #1,"  "
1620 PRINT #1,"Finishing time:";TIME$
1630 PRINT #1,"  "
1640 PRINT #1,"  "
1650 END
```

can be made by looking at the increases in time the programs take to process larger input files. To do so, I took the opening paragraph of Vladimir Nabokov's *Pnin* and generated 500 characters of fourth-order text. Then I took 1741 letters of George Bernard Shaw's introduction to *Man and Superman* and produced a 10,000-character text.

Using the formula given by Kenner and O'Rourke for their Pascal program, the two runs would take 0.8*k* and 27.6*k* seconds, respectively. (Here, *k* is a system constant.) My program took 5.5 and 81.5 minutes, respectively. Consequently, while the second program would have taken 32 times longer than the first with the Kenner and O'Rourke program, it took only 14 times longer with mine. So as the problems get larger, the advantage of using a tree structure becomes apparent. ■

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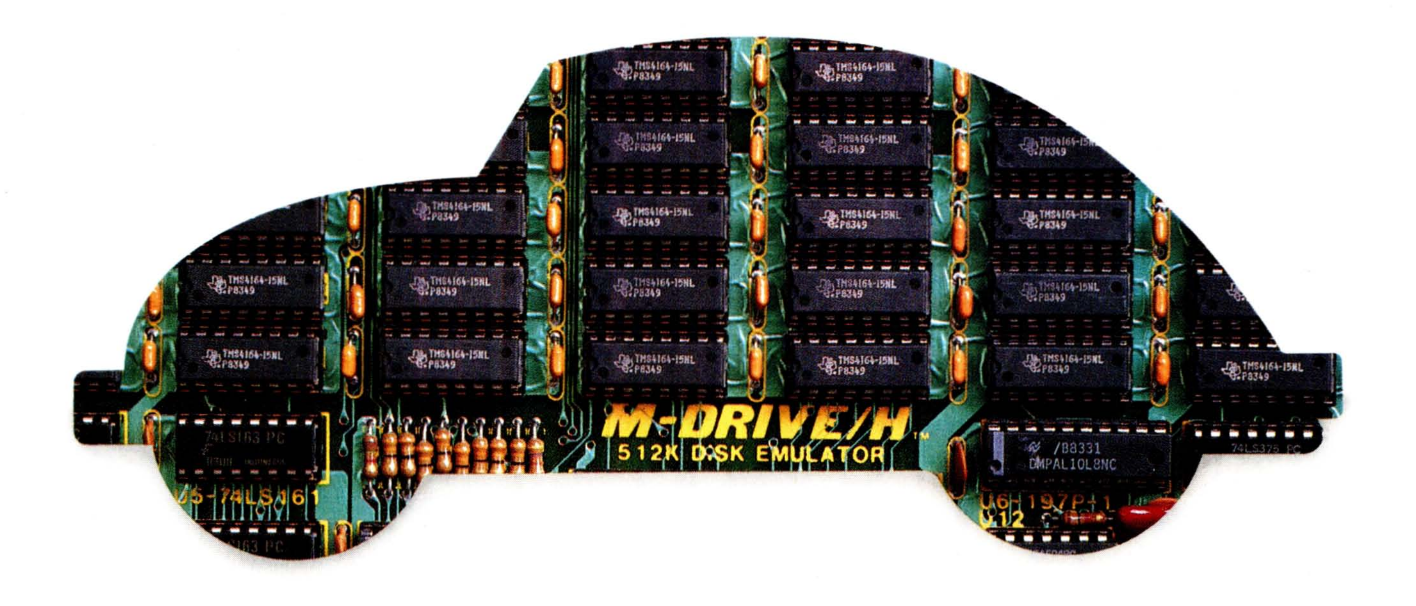
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PRINTING PASCAL GRAPHICS

BY KELLY W. DAVIS

A simple subroutine dumps Apple Pascal graphics to any Epson MX-series printer

I BOUGHT MY EPSON MX-80 printer and my Apple II computer with visions of graphics like the Mona Lisa dancing through my head. But I quickly discovered that Applesoft BASIC doesn't simplify graphics creativity. In fact, it forces any would-be da Vinci to delve into the mysterious realm of machine language. As everybody knows, machine language doesn't even make addition look easy, much less drawing complex pictures.

In desperation, I reverted to one of my favorite languages—Pascal. So far, Apple Pascal has met every creative expectation but one: It doesn't come with a screen-dump command. This might not seem like a big deal to a person who has never worked on more than one picture at a time. But after 30 or 40 graphics creations, a screen-dump routine comes in handy.

So I wrote one. Screendump (available for downloading from BYTEnet Listings at (617) 861-9774) takes whatever graphics are currently on the screen and dumps them to any MX-series printer from Epson. I wrote Screendump as an intrinsic unit under Pascal and stored it in the library. I can call my routine in any program under the USES statement and after the TURTLEGRAPHICS declaration.

Kelly W. Davis (292 Howe Ave. Apt. G, Sacramento, CA 95825) works at McClellan Air Force Base as a field service engineer and is a part-time student, majoring in mathematics.

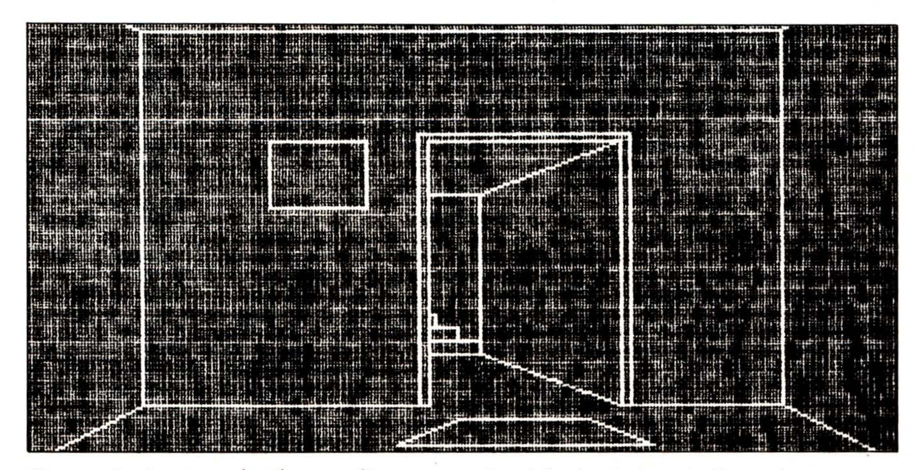


Figure 1: *An example of a graphics screen printed by intrinsic unit Screendump.*

After I've programmed my graphics creation, I type PRINTGRAPH. Screendump scans the screen from top to bottom 29 times. Each time it looks at the Boolean equivalent of either 2 or 7 graphics screen bits, converting them into their binary-coded equivalents. Screendump then stores them in a single-dimensional array (PRARRAY) 280 bytes deep, which is sent to the printer. Screendump takes about eight minutes. An example of the graphics screen printed by Screendump is shown in figure 1.

Dumping Apple Pascal graphics to a printer can be helpful if you need to develop many graphics screens, because instead of keeping them in your head, you can print each one out and enhance it individually. ■



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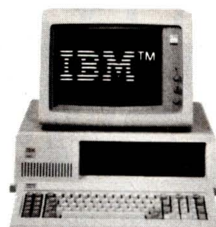
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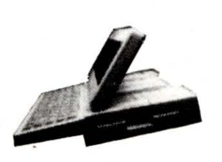


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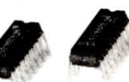


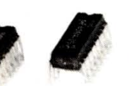
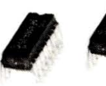
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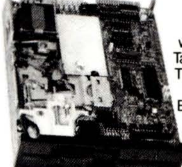



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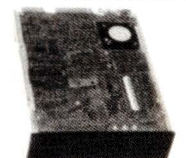


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NO CELEBRATION of BYTE's 10th anniversary would be complete without the acknowledgment of some of the events and contributions that helped to shape the magazine. In the too-few pages that follow, we tried to capture some of the flavor of the past 10 years.
Special thanks to all contributors and to the BYTE staff, especially Gregg Williams, who chaired the project, Richard Shuford, Rich Malloy, Mark Welch, and Stan Wszola.
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A MICROCOMPUTING TIMELINE

PHOTOGRAPHED BY PAUL AVIS

What follows is a modest and, we hope, correct timeline of personal computing. If the number of entries per year is any indication, then the most active years of personal computing were 1975, 1976, and 1977 and 1982, 1983, and 1984.

Although the roots of personal computing go back further, the excitement really started in January 1975, with the publication of Popular Electronics' *cover story on the Altair 8800. A slogan printed on the cover of the first three issues of BYTE said it all: "Computers—The World's Greatest Toy." The slogan expressed the ideal that lured many, but few of us had the stamina and consuming fanaticism needed to make it happen; you had to design and build* everything *yourself, hardware and software. Most of you also had to learn electronics, mathematics, and the art of deciphering arcane, poorly written spec sheets—the phrase "by your bootstraps" took on new meaning.*

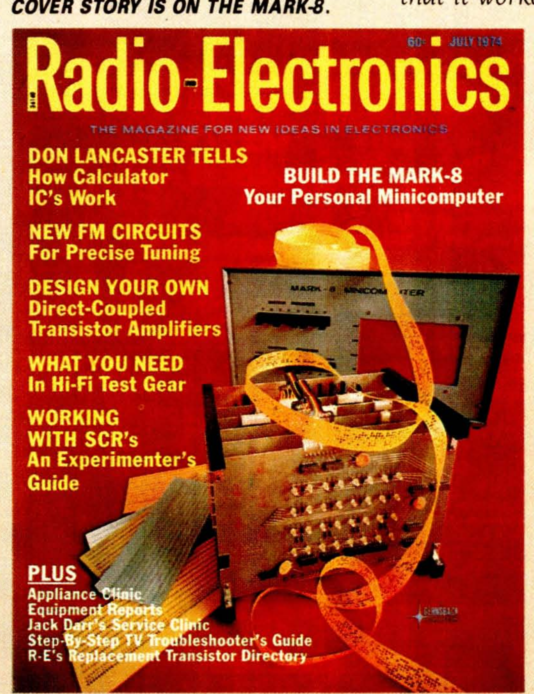
By 1978, things were different; you could buy microcomputers and they would usually work, but it wasn't the same. Prior to 1978, the excitement was in saying "Look, my design works!" But when you took it for granted that it worked, the question became "What can you do with it?"; however, the answer was "Not all that much." Most systems lacked a disk drive and had 32K bytes of memory or less. The years between 1978 and 1982 were slow, evolutionary years—not too exciting, but necessary.

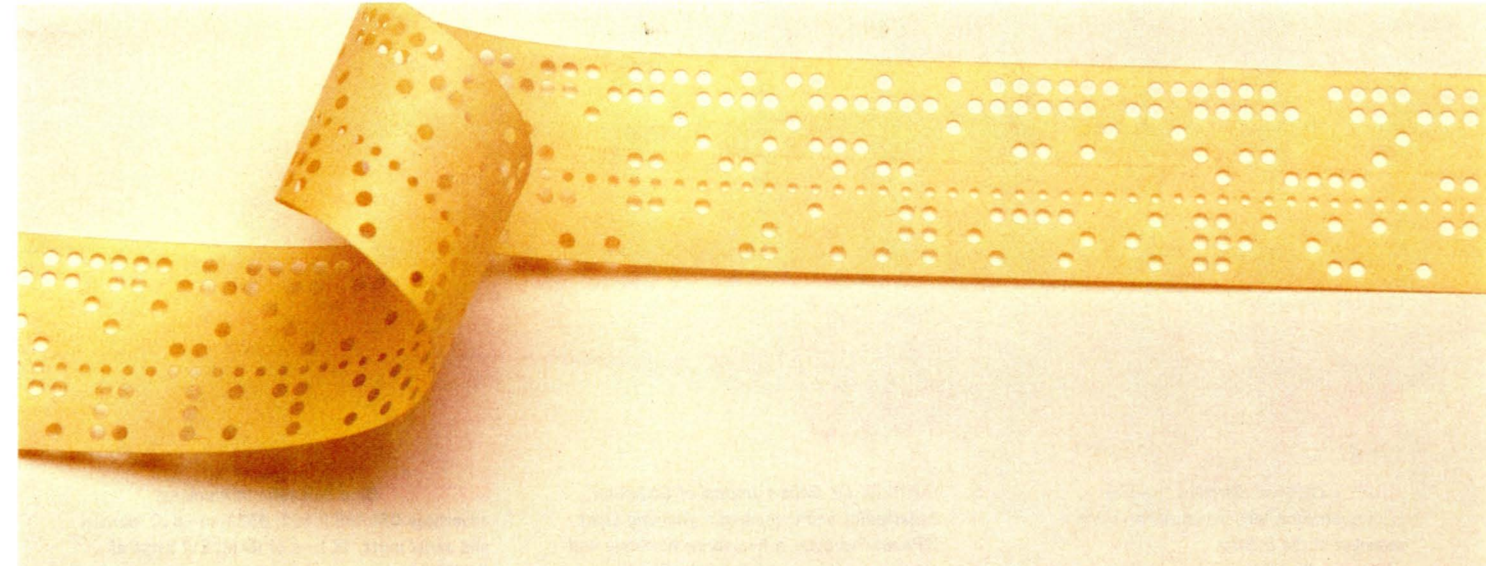
By late 1981, the industry was poised for growth, and IBM's introduction into the marketplace catalyzed that growth into a bumpy, breathtaking ride that shows no signs of slowing (though it did take about a year to get started, that is, to produce a significant number of IBM-related products). Personal computers finally could perform and were affordable enough to be used by people who weren't just hobbyists; that progress continues to build as computers become simultaneously cheaper and more capable.

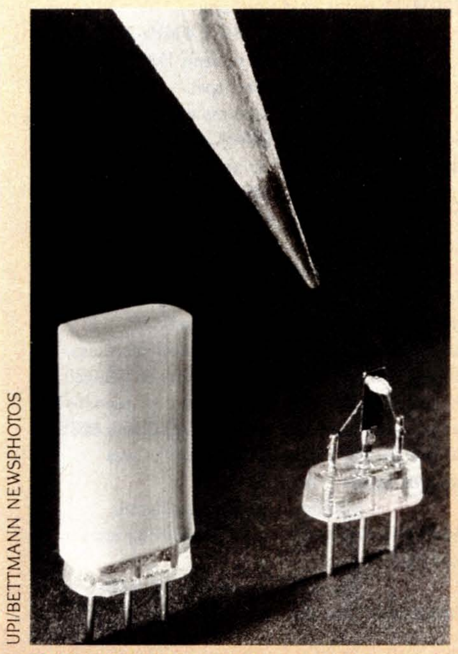
BYTE has kept a close watch on the computer industry's growth, and we felt the need to annotate this timeline. When dates have been difficult to pinpoint, we've approximated them. In general, it has been an active and interesting first ten years.

—Gregg Williams and Mark Welch

JULY 1974 ***RADIO-ELECTRONICS' COVER STORY IS ON THE MARK-8.***







***1948* THE TRANSISTOR IS INVENTED AT BELL LABORATORIES.**

Pre-1975

1948 John Bardeen, Walter Brattain, and William Shockley of Bell Laboratories invent the transistor.

1959 Texas Instruments unveils the first integrated circuit.

1964 John G. Kemeny and Thomas E. Kurtz develop the BASIC programming language at Dartmouth College.

Digital Equipment Corp. advertises the PDP-8 minicomputer, which, at $16,200, is "a full, general-purpose computer that scientists can afford—but it gets personal."

1970 OCTOBER *Scientific American* publishes Martin Gardner's first "Mathematical Recreations" column on John Conway's game of Life.

1971 Intel Corp. puts the 4-bit 4004 microprocessor on a single chip. Its initial price is $200.

1972 NOVEMBER Intel Corp. introduces the 8008, their first 8-bit microprocessor.

Nolan Bushnell founds Atari and ships the Pong video game.

1973 Scelbi Computer Consulting offers the 8008-based Scelbi-8H computer kit ($565 with 1K byte of memory).

FALL Intel Corp. announces the improved 8080 8-bit microprocessor.

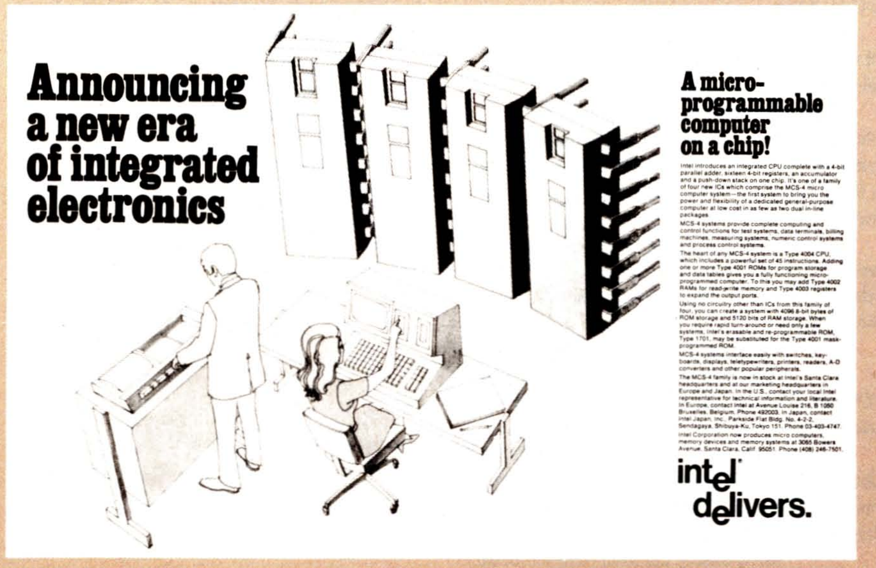
SEPTEMBER *Radio-Electronics* magazine publishes Don Lancaster's TVT-1 computer terminal project.

1974 Brian W. Kernighan and Dennis M. Ritchie develop the C programming language.

SUMMER Gary Kildall develops the CP/M operating system.

JULY *Radio-Electronics'* cover story is "Build the Mark-8: Your Personal Minicomputer."

SEPTEMBER *Creative Computing* magazine founded.



***NOVEMBER 1971* INTEL'S FIRST AD FOR THE 4004 MICROPROCESSOR IN ELECTRONIC NEWS.**

1975

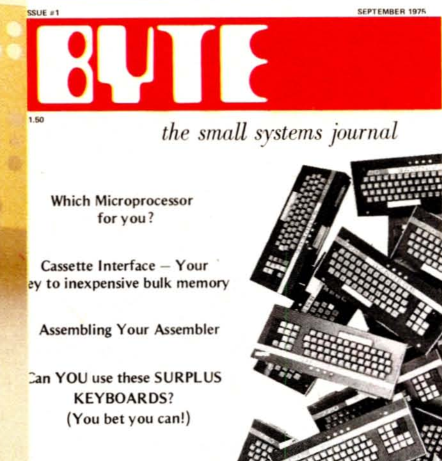
WINTER Zilog Inc. develops the Z80 microprocessor, whose instruction set is a superset of the 8080's.
JANUARY Carl Helmers founds *Experimenters' Computer System* (ECS), which lasts for five issues before he moves to BYTE.
JANUARY *Popular Electronics'* cover story is "World's First Minicomputer Kit to Rival Commercial Models...Altair 8800." The Altair 8800 kit, with an Intel 8080 microprocessor, 256 bytes of memory, and a toggle-switch-and-LED front panel, sells for $395.
MARCH Homebrew Computer Club founded.
MAY Amateur Computer Group of New Jersey founded.
SUMMER IMS International announces the IMSAI computer, which is essentially an improved clone of the Altair 8800.
SUMMER MOS Technology announces the MC6501 at $20 and the MC6502 at $25; at this point, the 8080 costs about $150.
FALL MITS (the company that sells the Altair 8800) announces 4K-byte and 8K-byte BASIC (from Microsoft's founders Bill Gates and Paul Allen) for $350 and $500, respectively ($60 and $75 for purchasers of complete Altair systems).
FALL Dennis Allison publishes Tiny BASIC—later enhanced by many, including Tom Pittman and Li-Chen Wang.
FALL Sphere Corp. offers the Sphere I computer kit (6800, 4K bytes of RAM, ROM monitor, keyboard, video interface, for $650).
FALL MOS Technology announces the KIM-1 microcomputer, an assembled single-board computer (6502, 1K byte of RAM, 2K-byte monitor in ROM, keypad, LED readout, cassette and serial interfaces, for $245).
SEPTEMBER IBM announces the IBM 5100, the first briefcase-size computer (with BASIC, 16K bytes, and a tape cartridge storage system, for about $9000.
SEPTEMBER BYTE publishes its first issue.
SEPTEMBER Godbout advertises the Pace kit in BYTE with "7 segment readouts for easy octal debugging."
NOVEMBER Southwest Technical Products Co. advertises the M6800 computer kit (6800, serial interface to terminal, monitor in ROM, for $450). Unlike the Altair, it has *no* front-panel switches!
DECEMBER MITS unveils the Altair 680 kit (6800, 1K byte of RAM, serial interface, for $293).
DECEMBER Microcomputer Associates Inc. offers the JOLT kit (6502, 512 bytes of RAM, serial interface to terminal, monitor in ROM, for $249).
DECEMBER Robert Tinney's first BYTE cover.

1976

JANUARY *Dr. Dobb's Journal of Computer Calisthenics and Orthodontia (Running Light Without Overbyte)*, a homebrew hardware and software magazine, publishes its first issue.
MARCH David Bunnell of MITS organizes the First World Altair Computer Convention in Albuquerque, New Mexico.
SPRING Texas Instruments announces its TMS9000, the first 16-bit microprocessor.
APRIL Apple Computer Inc. formed.
APRIL Cromemco Inc. advertises the Dazzler TV interface board—the first color display for a microcomputer.
SUMMER Keuffel and Esser (K&E) ceases its production of slide rules and donates its last one to the Smithsonian.
JUNE SwTPC M6800 ad promises "SOFTWARE—The flood is near. Editor and assembler now available. BASIC and more games right away. Yours for the cost of copying. WE DON'T SELL SOFTWARE—WE GIVE IT TO YOU. ENJOY IT, COPY IT, WE WON'T COMPLAIN..."
JUNE Scelbi releases SCELBAL, a BASIC-like language for $49 (includes source); it runs in 8K bytes of memory or more.
AUGUST First floppy-disk-drive ad in BYTE (iCOM Frugal Floppy, 8-inch, for $1195 [single quantity]).
AUGUST John Dilkes organizes the Personal Computing Festival in Atlantic City; it is the first microcomputer show of national scope.
AUGUST First portable computer: STM Systems' "BABY!" (6502, 2K bytes of RAM, bootstrap program in ROM, system software on tape, for $850 assembled).
FALL Steve Wozniak proposes that Hewlett-Packard Co. create a personal computer; Steve Jobs proposes the same to Atari—both are rejected.
SEPTEMBER Ohio Scientific Instruments advertises OSI 400 (6502, 6572, or 6800, parallel and serial ports, 1K byte of RAM, 512 bytes of PROM, kit prices—$140 and up).
OCTOBER Cromemco Inc. offers 4-MHz Z80 board for Altairs and other S-100 systems ($395 kit, with a monitor program on paper tape).
OCTOBER PolyMorphic Systems advertises the S-100—based POLY 88 (8080A, 512 bytes of RAM, video/keyboard interface board, 1K byte of ROM, cassette interface, for $685 in kit form).
NOVEMBER Steve Ciarcia's first article (not Circuit Cellar).
DECEMBER Processor Technology advertises the Sol computer (8080, S-100 bus, 1K byte of RAM, 1K byte of PROM, 1K byte of video RAM, keyboard, cassette, serial, and parallel interfaces, BASIC-5 on cassette—kit, $995; with dual 8-inch drives and operating system, $1895; an assembly-language TREK-80 game, PT 8K BASIC, and 8080 FOCAL are also available). The machine was invented by Lee Felsenstein.
DECEMBER Michael Shrayer writes Electric Pencil, the first popular word-processing program for microcomputers.
DECEMBER Shugart announces its 5¼-inch "minifloppy" disk drive for $390.



FALL 1975 THE SPHERE 1 COMPUTER KIT



APPLE COMPUTER INC.

APRIL 1976 APPLE I BOARD

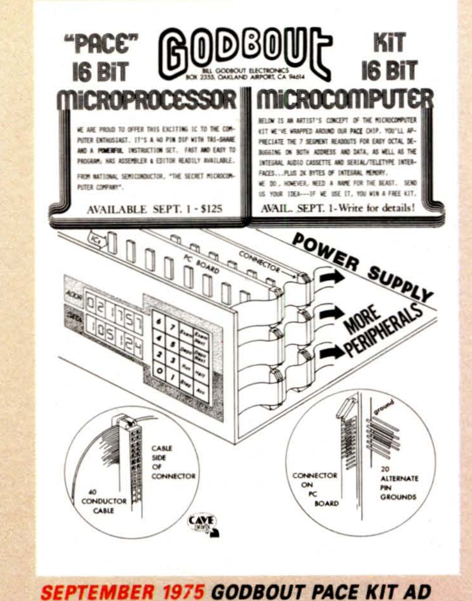
SEPTEMBER 1975 BYTE'S DEBUT



JUNE 1976 SWTPC SOFTWARE AD



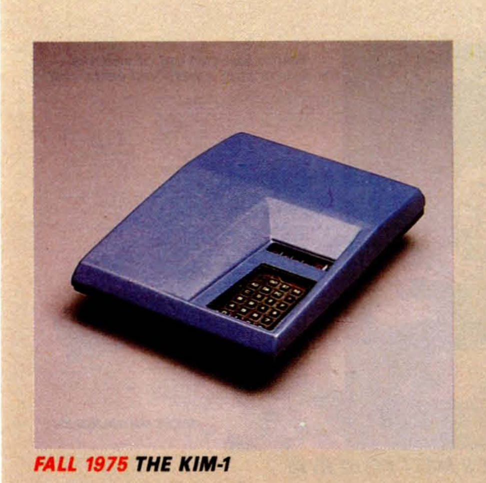
AUGUST 1976 ICOM'S FRUGAL FLOPPY AD



SEPTEMBER 1975 GODBOUT PACE KIT AD



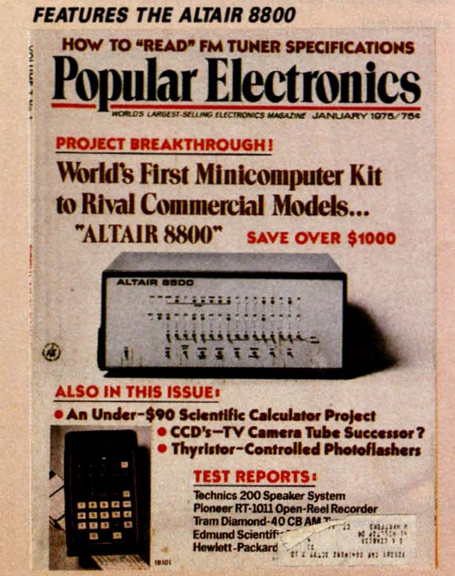
JANUARY 1975 POPULAR ELECTRONICS' FEATURES THE ALTAIR 8800



FALL 1975 THE KIM-1



JANUARY 1975 THE ALTAIR 8800



1977

WINTER Ohio Scientific Instruments offers the first microcomputer with Microsoft (floating-point) BASIC in ROM; it is also the fastest.
JANUARY *Kilobaud* (which later changed its name to *Microcomputing*) publishes its first issue.
FEBRUARY Computer Shack (which later changes its name to ComputerLand) opens its first store.
APRIL Jim Warren organizes the 1st West Coast Computer Faire in San Francisco. The Apple II and Commodore PET (see below) are introduced there.
APRIL Commodore Business Machines Inc. unveils its PET computer (6502, 4K bytes of RAM, 14K bytes of ROM, keyboard, display, tape drive, for $595 assembled). Its all-in-one packaging and 8K bytes of Microsoft BASIC were innovative. Its calculator-pad keyboard was (unfortunately) the precedent for later microcomputers.
JUNE Camp Retupmoc, the first week-long computer camp, is held in Terre Haute, Indiana.
JUNE Apple Computer Inc. runs its first ad in BYTE (6502, 4K bytes of RAM, Integer ROM and monitor in 16K bytes of ROM, keyboard, cassette interface, 8-slot motherboard, game paddles, graphics/text interface to color display, for $1298; with maximum 48K bytes of RAM, $2638).
AUGUST SwTPC offers a two-drive 6800 system with terminal, monitor, and computer for $1999.
AUGUST Microcomputers become more widely available (service does, too) through Radio Shack: their TRS-80 Model I (Z80, 4K bytes of RAM, 4K bytes of ROM [Level I BASIC], keyboard, display, cassette interface, and recorder) costs $599.95.
OCTOBER North Star Computers announces its Horizon computer (Z80A, 16K bytes of RAM, one 5¼-inch floppy drive, 12-slot S-100 motherboard, serial interface to terminal, $1599 kit, $1999 assembled).
NOVEMBER Ciarcia's Circuit Cellar begins.

1978

FEBRUARY Ward Christensen and Randy Seuss create the Computerized Hobbyist Bulletin Board System, the first major CBBS running on a microcomputer.
MARCH Kathe and Dan Spraklen's Sargon wins the 2nd West Coast Computer Faire chess tournament. (The 3rd takes place in Los Angeles in November.)
APRIL The Digital Group advertises the Byte-master, a sewing-machine-size computer housing a display, keyboard, and disk drive. Never very popular, it predates the Osborne 1.
MAY Ken Bowles first describes the machine-independent UCSD Pascal language/operating system in BYTE.
JUNE Exidy unveils the Sorcerer (Z80, 8K bytes of RAM, 12K bytes of ROM, keyboard, parallel, serial, and cassette interfaces, $895). The machine's innovations are its user-definable characters and its optional software on plug-in ROM cartridges.
AUGUST MicroPro International unveils Word-Master, the precursor of the ubiquitous WordStar word processor (which appears in mid-1979).
DECEMBER Epson America Inc. announces the MX-80 dot-matrix printer; its high performance and low price stun competitors and force competition and lower prices in the printer market.
DECEMBER Atari announces the Atari 400 and 800. The 800 has a full keyboard, 8K bytes of RAM (expandable to 48K via memory slots), two ROM cartridge slots, and custom graphics and sound chips designed by Jay Miner (who later designs the Amiga custom chips); it originally costs $1000. The machines do not become available until late 1979. A derivative machine (now costing under $100) is still on the market, and its graphics are unsurpassed in the 8-bit market.

1979

SPRING CompuServe, a telecommunications utility, founded.
MAY Dan Bricklin and Bob Frankston of Software Arts Inc. show the VisiCalc spreadsheet program at the 4th West Coast Computer Faire. This program caused many to take microcomputers seriously for the first time. VisiCalc was originally marketed by Personal Software (which later changed its name to VisiCorp), but Software Arts regained the rights to VisiCalc in September 1984. (VisiCorp merged with Paladin in late 1984, and Software Arts merged with Lotus in April 1985.)
MAY The FORTH Interest Group distributes the first public-domain version of fig-FORTH, which begins the eventual widespread availability of the language on microcomputers.
JUNE The Source telecommunications utility founded.
JUNE Texas Instruments unveils the TI-99/4, which originally sold for $1150 (which included a color monitor). The machine is slow (even though it uses TI's TMS9900 16-bit processor), the button-style keyboard is oddly laid out, and TI discouraged third-party software. The revised TI-99/4A solved some problems, but TI finally discontinued the computer in late 1983; its closeout price went as low as $50.
SUMMER Magic Wand becomes the first serious competitor to WordStar; it was just as powerful and easier to use.
SUMMER Wayne Ratliff develops the Vulcan database program (Ashton-Tate later markets it as dBASE II).



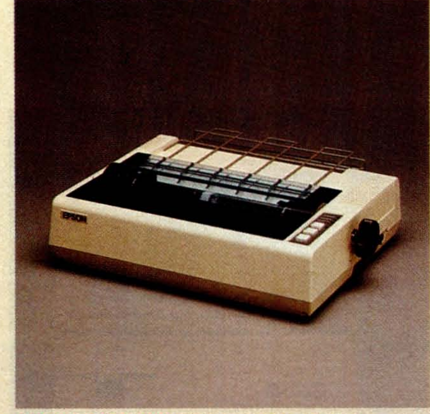
JUNE 1977 APPLE'S FIRST AD IN BYTE

ROSE-HULMAN INSTITUTE OF TECHNOLOGY
INVITES YOU TO SPEND SIX GRAND AND
GLORIOUS DAYS WITH US AT
CAMP RETUPMOC*
*An old Indian name for "Big Brain."
June 19-24; June 26-July 1, July 10-15; July 17-22

JUNE 1977 THE FIRST COMPUTER CAMP



JUNE 1979 THE TI-99/4A



DECEMBER 1978 THE EPSON MX-80



APRIL 1978 THE BYTEMASTER



DECEMBER 1978 THE ATARI 800



DECEMBER 1978 THE ATARI 400



AUGUST 1977 THE TRS-80 MODEL I



APRIL 1977 THE COMMODORE PET



FEBRUARY 1980 ***THE SINCLAIR ZX80***

1980

FEBRUARY *InfoWorld* publishes its first issue.
FEBRUARY Sinclair Research announces its ZX80 computer (Z80A, 1K byte of RAM, 4K integer BASIC in ROM, plastic membrane keyboard, $199). Its successor, the ZX81, was later marketed by Timex for under $100 before Timex left the microcomputer market.
MARCH Microsoft Corp. shows its first hardware product, the Z80 SoftCard for the Apple II at the 5th West Coast Computer Faire. The sudden availability of CP/M business software for the Apple contributes greatly to Apple Computer Inc.'s success.
MAY Apple Computer Inc. announces the Apple III, which is delivered a year late and has, at first, a high failure rate. The machine never becomes the replacement for the Apple II that Apple Computer wanted it to be.
JUNE Shugart begins selling 5¼-inch Winchester hard-disk drives.
JUNE Commodore Business Machines unveils the VIC-20 (6502A, 5K bytes of RAM, BASIC in ROM, serial, cassette, and modem interfaces, ROM cartridge slot, color display, for $299).
SUMMER Radio Shack announces its TRS-80 Color Computer (6809E, "chicklet"-style keyboard, 4K bytes of RAM, BASIC in ROM, color display, serial and cassette interfaces, for $399). They also announce the TRS-80 Model III, which replaced and improved their original Model I.
SUMMER "Zork, the Great Underground Empire" is first distributed by Personal Software Co. and later by Infocom, its creators. Infocom changed the nature of adventure games by allowing full-sentence input.
JULY Jerry Pournelle's "The User's Column" begins in BYTE.



MAY 1980 ***THE APPLE III***



NOVEMBER 1981 ***THE EPSON HX-20***



JUNE 1980 ***THE COMMODORE VIC-20***

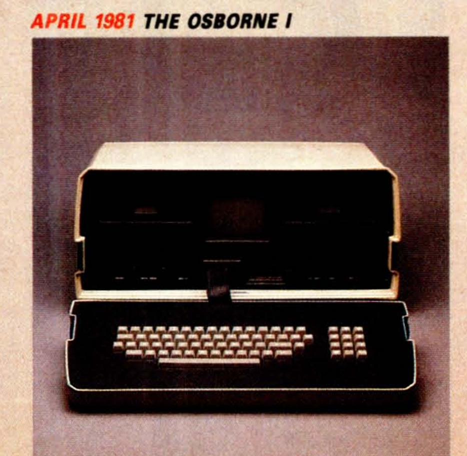


AUGUST 1981 ***THE IBM PC***



SUMMER 1980
ZORK—AN EARLY ADVENTURE GAME

APRIL 1981 ***THE OSBORNE I***



SUMMER 1981
THE HAYES SMARTMODEM 300



1981

WINTER Tracy Kidder's *The Soul of a New Machine* (New York: Avon Books) glorifies the inner workings of the computer industry and becomes a national bestseller.

FEBRUARY Steve Wozniak, principal designer of the Apple II, crashes the airplane he was flying. After recovering from injuries and amnesia, he moves to non-Apple tasks such as returning to the University of California at Berkeley for his undergraduate degree and (in September of 1982 and 1983) sponsoring music/technology weekends called US Festivals.

APRIL Adam Osborne, publisher of microprocessor books, surprises the industry with the $1795 portable Osborne 1 (Z80, 5-inch display, 64K bytes of RAM, keyboard and keypad, two serial interfaces, and two 5¼-inch disk drives). He also includes an impressive collection of bundled software whose list prices total more than the cost of the machine. The Osborne 1 had some flaws—low-density disk drives and a kludgy 52-character display—but it was a good machine for the money, and it caused competitors to produce similar computers at a lower cost than was common at the time.

MAY Xerox Corp. unveils the Star (later called the 8010). This is Xerox's first commercial product derived from over a decade of work at Xerox PARC (Palo Alto Research Center). Costing over $50,000 for the smallest usable configuration, the computer has little direct effect; however, its use of icons, the "desktop metaphor," and the mouse pointing device begin to influence the microcomputer market in 1983 (with Apple Computer Inc.'s announcement of the Lisa computer).

SUMMER Hayes Microcomputer Products Inc. advertises the Smartmodem 300, which becomes the industry standard.

AUGUST IBM introduces the IBM Personal Computer (PC) (8088, 64K bytes of RAM, 40K bytes of ROM, one 5¼-inch disk drive, $3005), which legitimized the microcomputer industry to the rest of the world and established the preeminence of the Intel 8086-family processor and the Microsoft MS-DOS operating system.

SEPTEMBER BYTE publishes "A High-Level Language Benchmark" by Jim Gilbreath. This article makes the Sieve of Eratosthenes benchmark program infamous; it is later used to test hundreds of computer/language combinations.

NOVEMBER Epson America Inc. shows the HX-20, the first laptop computer, at COMDEX. The unit weighs less than 3 pounds and runs a CMOS (complementary metal-oxide semiconductor) equivalent of the 6801 and 16K bytes of RAM on internal batteries. Its 20-character by 4-line display, however, reduces its usefulness.

SUMMER 1982 ***THE COMMODORE 64***

1982

JANUARY Radio Shack announces the TRS-80 Model 16 (68000 and Z80, 128K bytes of RAM, one 8-inch disk drive, for $4999).

APRIL BYTE's Famous Programmer's School ad.

APRIL Non-Linear Systems (later named Kaypro Corp.) announces the Kaycomp II (later named Kaypro II), a portable computer with a full 9-inch screen and considerable bundled software, meant to compete with the Osborne at $1795.

APRIL GRiD Systems announces the Compass, a futuristic briefcase-size portable computer with an electroluminescent display, for $8150. Despite several price cuts and feature changes, the computer never becomes popular. (GRiD was to announce a new product line in the summer of 1985.)

APRIL Xedex Corp. builds the Baby Blue card (a Z80 coprocessor card) to ease the lack of software for the 9-month-old IBM PC.

SPRING Franklin Computer Corp. unveils the Ace 100, the first legal Apple II clone.

JUNE Columbia Data Products Inc. advertises the MPC, the first IBM PC clone. Compaq Computer Corp. follows in November, and IBM PC cloning and claimed compatibility become a way of life in the industry.

SUMMER Commodore Business Machines Inc. announces the Commodore 64 (6510, 64K bytes of RAM, 20K bytes of ROM [including Microsoft BASIC], custom sound chip, color graphics, serial interface, for $595). During 1983, its price drops to around $200 and it eventually takes the market away from the Atari 800-series computers.

SUMMER The Logo programming language becomes readily available for several computers, most notably the Apple II and the TI-99/4A.

JULY Motorola Inc. and Hitachi America Ltd. release preliminary specifications for 256K-bit chips (they become available in late 1983).

JULY Intel Corp. announces the 80186 and 80286, more powerful processors that are compatible with the 8086 and 8088.

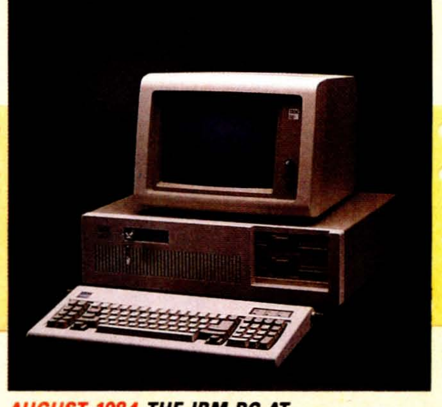
FALL U.S. Customs refuses to allow the custom chess-playing computer Belle to be taken to Moscow to play in exhibition. Ken Thompson, its inventor, notes that the only way it might be used as a weapon would be "to drop it out of an airplane. You might kill somebody that way."

OCTOBER Lotus Development Corp. announces 1-2-3, a fast spreadsheet/graphing program with some list-handling capability for the IBM PC. Its speed and capabilities allow it to replace VisiCalc as the industry standard, and its combination of several functions into one program starts the "integrated software" movement in microcomputers.

DECEMBER Volition Systems announces the first implementation of the Modula-2 language. It runs on an Apple II under the Softech p-System.

1983

JANUARY Commodore Business Machines Inc. sells its one-millionth VIC-20.
JANUARY Ill-fated computers: Atari unveils the 1200XL, and Mattel belatedly announces the Aquarius. Both are later discontinued, and Mattel gets out of electronic products entirely.
JANUARY *Time* magazine selects the Computer as its "Man" of the Year.
JANUARY Apple Computer Inc. unveils the Lisa computer at its annual stockholders' meeting. The machine is slow but innovative. It originally costs $9995, but its price goes as low as $4495 (with a 5-megabyte hard disk). By this time, however, the Macintosh is in the news.
FEBRUARY IBM announces the IBM PC XT. It adds a 10-megabyte hard disk, three extra slots, and a serial interface to the basic IBM PC design. With 128K bytes of RAM and one disk drive, it costs $4995.
MARCH Radio Shack announces the TRS-80 Model 100, its first laptop. The unit weighs almost 4 pounds and has an 40-character by 8-line LCD (liquid-crystal display). It becomes very popular with journalists and businesspeople because of its built-in text editor and modem.
APRIL Microsoft Corp. announces Multi-Tool Word (later shortened to "Word").
MAY AT&T Information Systems announces the UNIX System V operating system.
JUNE Microsoft Corp. and numerous Japanese companies announce the MSX standard for low-cost Z80-based computers. It enjoys considerable success in Japan but none in the U.S..
JUNE Coleco announces the Adam, a Z80-based computer with a daisy-wheel printer, 64K bytes of RAM, and a tape-cartridge mass-storage device, for $600. Coleco delivers late, raises the system's price, repairs many defective units, and discontinues the product by the end of 1984.
JUNE Apple Computer Inc. ships its one-millionth computer.
SEPTEMBER Hewlett-Packard Company announces the HP 150, later renamed the Touchscreen.
SEPTEMBER Osborne Computer Corp. files for protection from creditors under Chapter 11.
OCTOBER IBM announces the IBM PCjr. The 128K-byte floppy-disk version first sold for $1269 and was crippled by lack of expansion and a cheap "chicklet"-style keyboard. Though these problems were fixed, IBM discontinued the PCjr in March 1985.



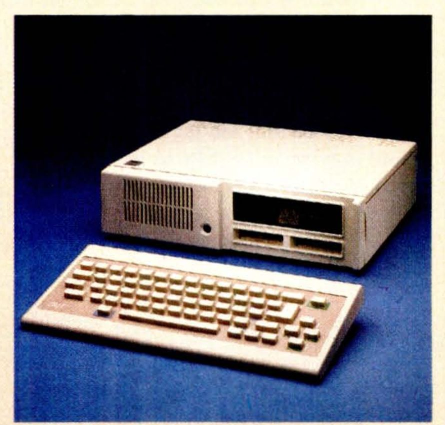
AUGUST 1984 ***THE IBM PC AT***



JANUARY 1983 ***THE LISA***



JANUARY 1984 ***THE MACINTOSH***



OCTOBER 1983 ***THE IBM PCJR***



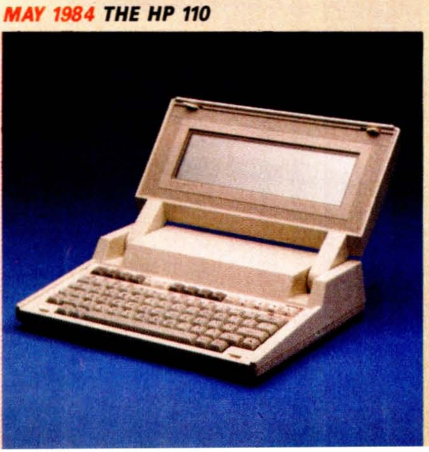
MARCH 1984 ***THE AT&T 3B2/300***



SEPTEMBER 1983 ***THE HP 150***



MAY 1984 ***THE HP 110***





JANUARY 1983 ***TIME'S MAN OF THE YEAR***

OCTOBER Western Design Center introduces the 65802 and the 65816, both 16-bit versions of the popular 6502 chip. These chips were still not available in early 1985.
OCTOBER Shugart Corp. announces a $7600 1-gigabyte write-once optical-disc drive.
OCTOBER In Japan, Canon displays an under-$2000 300-dot-per-inch laser printer for OEM (original equipment manufacturer) use.
OCTOBER Borland International Inc. advertises Turbo Pascal for CP/M and 8086-based computers. Its quality, speed, and low price make it a de facto standard, especially in the IBM PC world.
OCTOBER Ovation Technologies announces Ovation, an ambitious integrated IBM PC software package that gets shown at several conventions but never gets shipped—the term "vaporware" is coined to describe it and similar products.
NOVEMBER Microsoft Corp. announces Windows, its multiple-window software product for the IBM PC, a package that became available in summer of 1985.
DECEMBER Tandy (Radio Shack's parent) announces the Tandy Model 2000, a $2999 IBM PC clone with enhanced features and an 80186 processor.

1984

JANUARY Apple Computer Inc. introduces the Macintosh. At $2495 for a computer that needs considerable expansion for many applications, it's hardly "the computer for the rest of us," but its innovations (which draw considerably from its ancestors, the Xerox 8010 and the Apple Lisa) continue to influence many other microcomputer products.
JANUARY Seiko Instruments U.S.A. Inc. displays the first wristwatch computer; it has a 10-character by 4-line LCD, 2K bytes of CMOS RAM, and 6K bytes of ROM.
JANUARY Sinclair Research announces the Sinclair QL (68008, 128K bytes of RAM, two cassette-loop mass-storage drives, bundled software, and other features) for £399 in the U.K. The computer is not made available in the U.S.
FEBRUARY Lotus announces Symphony, its $695 spreadsheet-oriented integrated package whose complexity limits its success.
MARCH AT&T unveils its 3B2/300 UNIX-based supermicrocomputer for $9950; the computer uses the Western Electric 32000 CMOS processor.
MARCH Ashton-Tate announces Framework, its word-processor-oriented $695 competitor to Symphony.
APRIL Mindset Corp. announces the Mindset PC, a graphics-oriented microcomputer with custom graphics chips and some IBM PC compatibility. Although its enclosure won a design award that put it in the Museum of Modern Art's design collection, the microcomputer market in 1984 was not able to support a new computer.
MAY Apple Computer Inc. unveils the Apple IIc with a morning-to-night publicity extravaganza that sets a new standard for such things in the industry.
MAY Hewlett-Packard Co. announces the HP 110, a 9-pound $2995 portable that includes Lotus's 1-2-3 in ROM.
JUNE Motorola Inc. adds the 68020 32-bit processor to its 68000 family.
JUNE Tom Jennings releases the Fido computerized bulletin-board system, which runs on many MS-DOS microcomputers, into the public domain. By 1985 there are over 300 Fido "nodes" in the U.S.
JULY Jack Tramiel (formerly head of Commodore Business Machines Inc.) buys Atari from Warner Communications.
AUGUST Commodore Business Machines Inc. buys Amiga Corp. and its graphics-intensive 68000 computer design.
AUGUST IBM announces the IBM PC AT (80286, 256K bytes of RAM, one 1.2-megabyte floppy-disk drive, and other items—minimum working system, $5469) and its PC Network local-area network.
FALL Digital Research Inc. announces its GEM icon/desktop user interface for 8086-based computers. (GEM is later used by Atari in its $395 68000-based "Jackintosh.")
OCTOBER Data General Corp. announces the DG/One, a 10-pound, $2895 battery-powered portable computer with most of the features of a fully configured IBM PC. The machine is criticized for an LCD that is hard to read, a point that DG corrects to some extent in a later model.
DECEMBER IBM acquires Rolm Corp., a communications equipment company; this gives IBM a competitive edge against AT&T, which has entered the computer market.
DECEMBER Osborne Computer Corp. emerges from bankruptcy proceedings with the Vixen, a $1298 Z80-based, two-drive portable with bundled software.

NOTABLE QUOTES

"What peripheral device most often describes the home hacker's ultimate system? It is, if course, the floppy disk."

—Ira Rampil, December 1977 BYTE

"In less than eight months, more than five thousand people have proudly purchased WordStar. . . ."

—a MicroPro ad, April 1980 BYTE

"The sin of inefficiency is venial compared to the mortal sin of "user-unfriendliness." I'd buy an operating system any day that takes a long time to run a given program but which makes me more productive by communicating with me in useful ways."

—Chris Morgan, June 1981 BYTE

"The current personal computer market is about the same size as the total potato-chip market. Next year it will be about half the size of the pet-food market and is fast approaching the total worldwide sales of panty hose."

—James Finke, President, Commodore International Ltd., February 1982 BYTE

"CP/M 2.2. is extremely important, and the Z80 chip will live forever because of it."

—Portia Isaacson, Future Computing Inc., May 1982 BYTE

"To be a real hacker means to dedicate a substantial part of your life to the advancement of some application of a technology. It means going behind the backs of stuffed-shirt administrators who think that, despite their inability to do the technical work, they have royal prerogatives to push the technologists this way and that to satisfy obscure, largely symbolic organizational needs.

"To be a real hacker means to make a magnificent obsession of creating some effect previously unknown, especially when others say you cannot or may not do it. You will impoverish yourself, devote your whole being to the task, and go far beyond the limits that reasonable people place on unremunerative effort."

—Lee Felsenstein, 1985



A decade of personal computer development displayed at The Computer Museum in Boston.

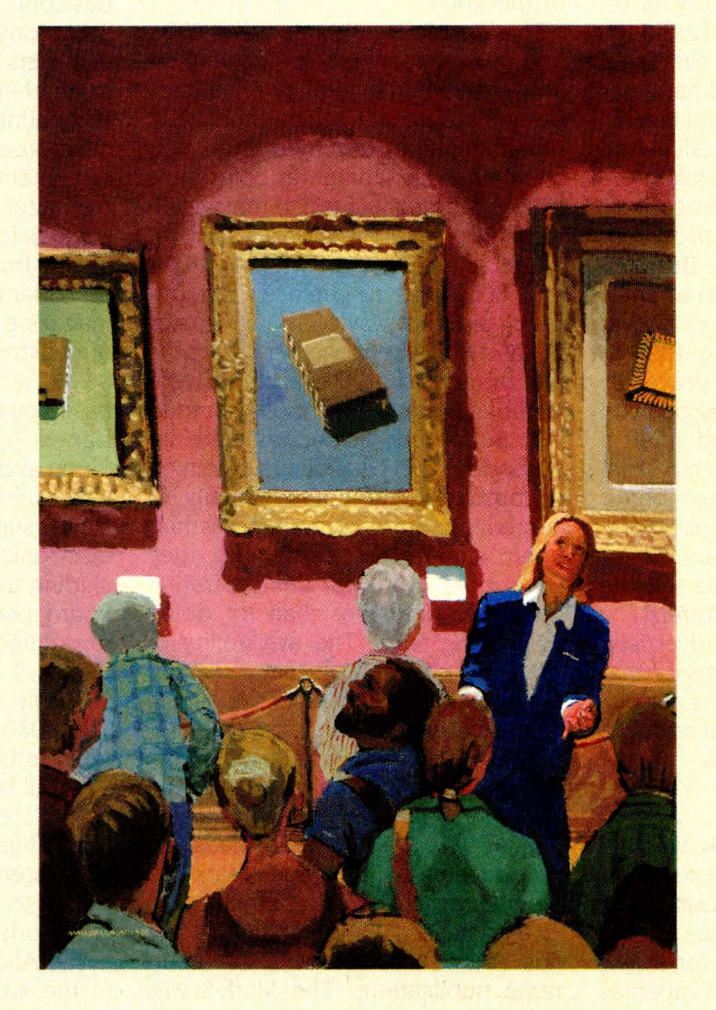
PHOTOGRAPHED BY PAUL AVIS

EVOLUTION OF THE MICROPROCESSOR

An informal history

BY MARK GARETZ

Author's note: The evolution of the microprocessor has followed a complex and twisted path. To those of you who were actually involved in some of the following history, I apologize if my version is not exactly like yours. The opinions expressed in this article are my own and may or may not represent reality as someone else perceives it.



THE TRANSISTOR, developed at Bell Laboratories in 1947, was designed to replace the vacuum tube, to switch electronic signals on and off. (Although, at the time, vacuum tubes were used mainly as amplifiers, they were also used as switches.) The advent of the transistor made possible a digital computer that didn't require an entire room full of vacuum tubes, relays, and special air conditioning. Now a computer would take up only *half* a room and operate much more quickly.

It was not until 1959 that engineers at Texas Instruments figured out how to put more than one transistor on the same material (called the substrate) and connect them together without wires. Thus was born the integrated circuit, or IC. Today these thin flat pieces of silicon can contain millions of transistors, and we call them chips.

Integrated circuits may range from SSI (small-scale integration, containing relatively few transistors), through MSI (medium-scale integration, around 50 or more transistors), LSI (large-scale integration, with thousands of transistors), to VLSI (very-large-scale integration, which can contain millions of transistors).

In 1969, a year-old company named Intel announced a 1K-bit RAM chip. There were not yet any microcomputer chips to hook it to, but there were many other applications for the new memory chip, which was significantly larger than any that had been produced before.

About this time, the summer of 1969, Intel was approached by the Japanese calculator manufacturer Busicom to produce a set of custom chips designed by Busicom engineers for the Japanese company's new line of calculators. The calculators would have several chips, each of which would contain 3000 to 5000 transistors.

Intel designer Marcian (Ted) Hoff was assigned to assist the team of Busicom engineers that had taken up residence at Intel. Hoff looked at the Busicom design and decided it was too complex to be cost-effective. He had worked before with Digital Equipment Corporation's PDP-8 minicomputer, which had a very small instruction set. He reasoned that much of the calculator's complexity could be reduced if they used a small general-

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ILLUSTRATED BY WILLIAM LOW

purpose processor. Such a design, using software rather than electronics to do the calculating, would greatly increase the memory requirements of the calculator—but then, Intel was in the memory business. Hoff also realized that this processor could be put to other applications and he sold the idea to Intel management.

The Busicom engineers were still pursuing their original design when Hoff and his group started work on their alternative design. And although the Busicom engineers had simplified their design, each chip still had over 2000 transistors, and it would take 12 chips to make a working calculator. Hoff's team figured it would take 1900 transistors to build their processor.

Hoff's general-purpose processor design was chosen over the Busicom design, and Intel got a contract from Busicom to produce the chip that later became known as the 4004.

Actually making the chip proved to be difficult until Federico Faggin (who later founded Zilog) joined Intel in early 1970. He took the chip from concept to silicon in just nine months. At first Intel sold the 4004 exclusively to Busicom, but in the summer of 1971, it gained the right to sell the chip set to other manufacturers.

In November 1971 Intel advertised the 4004 as a four-bit processor that performed 60,000 operations per second. By February 1972 Intel had sold $85,000 worth of chip sets.

THE BIRTH OF 8-BITS

At the same time the 4004 was being developed, CTC (Computer Technology Corporation, now Datapoint) asked both Intel and Texas Instruments to design LSI chips for a new intelligent terminal. Both companies proposed an 8-bit general-purpose processor. Note the pattern developing: 4-bits for calculators because they work in BCD (binary-coded decimal) and 8-bits for terminals because they deal with ASCII characters.

Interestingly, CTC chose neither solution; it built its terminal with standard logic ICs. But TI and Intel went ahead with their projects anyway. TI eventually got a patent on its chip design and the project at Intel gave birth to the 8008.

The 8008, introduced in April 1972, was the first 8-bit microprocessor on the market. It required at least 20 support chips, but it had 45 instructions that it executed at 300,000 instructions per second, and it adddressed a whopping 16K bytes of memory. That was a lot of memory then, and the 8008 was a considerable upgrade of the 4004.

The documentation for the 4004 and 8008 was cryptic (at least it seemed so to me; I didn't have a computer background at the time). The documentation assumed that you knew what everything was before you started reading it (a still-common failing of technical literature).

Intel's primary goal with the 4004 and 8008 was to replace "random logic"—another way of saying "lots of SSI and MSI wired together." Few people thought that these chips were suitable for general-purpose computing. But a few visionaries were intrigued by the possibility of owning a computer that could actually *do* something. True, computer kits had been offered previously, but they were more useful for demonstrating computer principles than for doing computing tasks. The availability of the 8008 changed all that.

In 1973 Scelbi Computer Consulting Inc. announced the first general-purpose microcomputer based on the 8008. This was followed by the RGS-008 from RGS Electronics. Then, in July 1974, *Radio-Electronics* magazine introduced Jonathan Titus's Mark-8 in a series of construction articles.

Until then, all computer articles and ads had been confined to amateur-radio publications. The Mark-8 was the first computer to hit a general-interest electronics magazine. These early microcomputers were still more demonstration tools than useful, but the small-computer revolution had begun.

THE MIGHTY 8080

In April 1974 Intel changed the way we think about computers forever. They announced the 8080, a significant upgrade to the 8008 that required only six support chips, had 75 instructions and a tenfold increase in throughput over the 8008, and addressed 64K bytes of memory. (No program, most people thought, could ever be *that* large!)

The 8080 design was proposed by Faggin, but the design team was headed by Masatoshi Shima, a young engineer Intel had wooed away from Busicom. Having learned from the limitations of the 4004 and 8008, the designers made improvements to make their new chip a truly useful computing engine. The 8080, the first microprocessor not aimed at logic replacement, looked much more like a computer than anything that had come before it, and it was much easier to use from a hardware standpoint.

The January 1975 *Popular Electronics* magazine featured the first in a series of construction articles on the Altair 8800, a so-called "minicomputer" based on the 8080. The Altair was designed by MITS (Micro Instrumentation and Telemetry Systems), which was founded by Ed Roberts as a vehicle for supporting his experiments in electronics. The whole Altair kit, including the 8080 processor, motherboard, power supply, front panel with lots of lights, and 256 bytes (*not* 256K bytes) of memory sold for $395.

People thought it was a misprint. The 8080 chip, introduced just nine months before, had been selling for $360 all by itself. But MITS had made a special deal with Intel, and the price of the Altair was real. MITS sold more computers in the first day than it had hoped to sell during the whole life of the product.

The Altair played a significant role in the success of the 8080, largely because programmers now had a reason (and a good excuse) to write software for a microcomputer chip. Also, the Altair's open bus architecture (an improved version of which later became the S-100/IEEE 696 bus) allowed people to begin making peripherals for the computer.

One such peripheral was a disk controller from Digital Microsystems that featured the use of a new operating

system for the 8080 called CP/M (Control Program for Microcomputers.) CP/M, brainchild of Naval Postgraduate School instructor Gary Kildall, sold for $70 and played a major role in the success of the 8080 and its architecture. As a result, a large portion of the microcomputer software in use today either runs on the 8080 instruction set or is a direct upgrade of a product that did.

THE MOTOROLA FAMILY

In response to the 8080's success, Motorola began work on the 6800, which was designed by Chuck Peddle. Motorola was the first company to introduce a line of peripheral chips designed specifically to go with its microprocessor. These chips included parallel (6820) and serial (6850) I/O functions and made the integration of these functions into a system simple for system designers.

Motorola produced one other significant "peripheral": a huge microprocessor applications manual, bigger than all other microprocessor documentation put together. And it was almost readable! Hackers and system designers like myself rushed out and bought them at $25 each. True, the manual was still oriented toward logic replacement, and you needed a minicomputer and expensive cross-assemblers to write software. No one had yet written anything that really explained these new chips to people who had no idea what they really were inside, or who had no computer experience. But we read the Motorola manual anyway. . . it was all we had.

Chuck Peddle left Motorola to join MOS Technology (not to be confused with Mostek, the subsidiary of United Technologies), a leader in the scientific-calculator-chip field. In June or July 1975, MOS Technology ads appeared in the electronics trade journals claiming that the company would be introducing and delivering a $20 microprocessor at the WESCON show that September. The so-called 6501 was to be pin-for-pin plug-compatible with the Motorola 6800—you could unplug the 6800 from a circuit board and plug the 6501 right into the same socket and it would work—although the software would also need changing because of differences in the architecture and instruction set. MOS was also planning a version of the chip with the complex clock circuitry required by other microprocessors built in. This would be the 6502 and would cost $25.

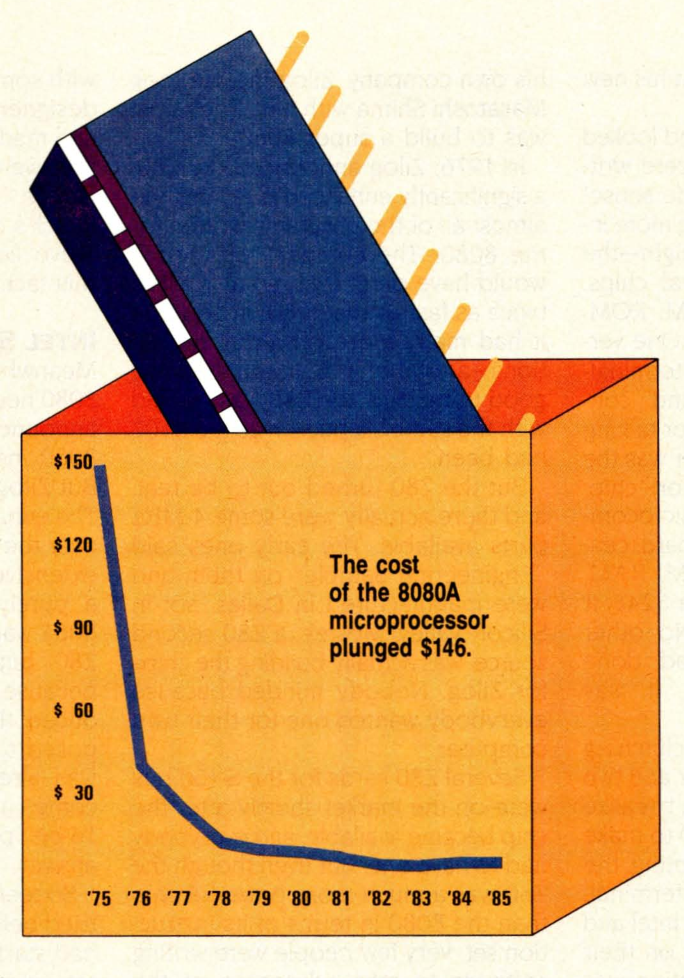
The industry went into an uproar. At this time, Intel's 8080 and Motorola's 6800 were both selling for $179 in single-piece quantity. I remember standing in the lobby (actually a living room) of E-Mu Systems with Scott Wedge and Dave Rossum, who had just designed some 8080s into their synthesizers. We were talking with an Intel salesperson who dismissed the ad as a hoax. He said Intel had assured him that MOS couldn't possibly do it at that price, and that either the ad was a publicity stunt or MOS Technology was quoting the million-piece price. I said that there was no reason that microprocessor chips wouldn't go the same way as scientific calculator chips had—originally hundreds of dollars, now just a few dollars. He said that the chips would never go below $100.

The salesperson's attitude was nearly universal in Silicon Valley—but MOS Technology was on the East Coast. I called them up, and they insisted that they were serious and that yes, that was the single-piece price. I, and the rest of the valley, would have to wait for WESCON to find out.

WESCON finally came and there was the MOS Technology booth—but no chips. The company had discovered when it got there that exhibitors weren't allowed to sell anything on the show floor. The chips, company representatives said, were available in their hospitality suite in a nearby hotel.

I went to the suite that evening, and it was packed. The chips were in two large fishbowls. MOS also had hardware and software manuals available for $5 each. Ray Stevens, who owned RGS Electronics and had designed the RGS-008, was tending bar. Steve Wozniak was there, along with a lot of other people including Chuck Peddle,

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The cost of the popular 8080A microprocessor from 1975 to 1985. Note that in 1975 only the 8080 microprocessor was available.

who was happy to talk about his new processors.

I sat down on the couch and looked at the two manuals. They were written in English and they made sense!

MOS was also showing one more innovation in the suite that night—the first multifunction peripheral chips. The company had put RAM, ROM, timer, and I/O on one chip. One version was called the TIM (terminal-interface monitor) chip and contained a complete monitor for talking to a serial terminal. The other was the KIM (keyboard-input monitor) chip, and it was designed into a microcomputer board that had a keyboard, central processor, display, ROM, RAM, and parallel I/O, and sold for $245. It was a complete system. No other microprocessor vendor had done anything like this before. It was impressive.

I went home that evening clutching my $25 6502 microprocessor and two manuals. At the time I didn't realize I would spend another $300 to make a working system, not counting the ASR-33 Teletype I used as a terminal.

That first day of WESCON, Intel and Motorola lowered the price on their chips to $69.95. The revolution was in full swing. The industry would never be the same.

The 6501 was short-lived. Motorola sued MOS Technology charging that Chuck Peddle had stolen the technology from Motorola and that the 6501 infringed because it was plug-compatible. MOS Technology agreed to drop the 6501.

However, the many computers that were developed around the 6502 are now legend: MOS Technology's own KIM-1, the Apple I and II, the Atari models, and the Commodore PET and VIC-20, among others. Actually, the future of the 6502 was still questionable when fledgling Apple Computer Inc. produced the Apple I. Steve Wozniak put in a jumper connection that could be changed to allow the 6800 to be used instead of the 6502.

ENTER THE Z80

Sometime in late 1975 or early 1976, Federico Faggin left Intel and formed his own company, Zilog Inc. He took Masatoshi Shima with him. Their goal was to build a super 8080.

In 1976, Zilog announced the Z80, a significantly enhanced 8080 that ran almost all of the programs written for the 8080. The company claimed it would have parts that ran at 4 MHz, twice as fast as the 8080. In addition it had many more powerful instructions—a total of 176. It sounded too good to be true; the Z80 was treated with the same skepticism as the 6502 had been.

But the Z80 turned out to be real, and there actually were some 4-MHz parts available. The early ones said "Engineering Sample" on them and were manufactured in Dallas, not in Silicon Valley. Mostek, a Z80 second source, was actually building the chips for Zilog. Nobody minded because everybody wanted one for their own computer.

Several Z80 cards for the S-100 bus were on the market shortly after the chip became available, and everybody had to have one. But even though the Z80 was a much more powerful chip than the 8080 in terms of its instruction set, very few people were writing software to take advantage of the Z80's extra instructions. The reason was simple: The majority of the machines installed at that time were 8080-based, and if you wrote code that only ran on a Z80, your market would be considerably smaller. This problem plagues the Z80 even today.

However, designers stopped using the 8080 in new computers. The Z80 was a far easier chip to use, requiring no support ICs and only a single-voltage power supply. And it was much faster, even if you didn't use the extra instructions.

The Z80 introduced one other new concept to microcomputer chips: built-in support for refreshing dynamic RAMs. Dynamic RAMs have always cost about four times less per bit than their static counterparts, and that made them very attractive to use. However, because you have to refresh them (or else they forget their data), they are extremely difficult to use, and early system designers viewed them with some distrust. The Z80 gave the designer 90 percent of the solution and made it possible to build systems that were significantly cheaper than before. Computers such as Radio Shack's original TRS-80, designed by Steve Leininger, took advantage of this fact.

INTEL STRIKES BACK

Meanwhile, Intel had realized that the 8080 needed upgrading. In 1976 Intel announced the 8085. It had all the 8080 instructions, plus a few more. But Zilog had taken Intel by surprise. The enhancements that the 8085 had over the 8080 were nowhere near as extensive as those of the Z80. From a purely hardware standpoint, the 8085 was a much nicer chip than the Z80, but the Z80 had mass appeal because it was faster. When introduced, the 8085 ran at 3 MHz, as opposed to the 4-MHz chip that Zilog was already shipping. Intel had to come up with something else—a 16-bit processor seemed like the answer.

Sixteen-bit processors had been tried before. National Semiconductor had started work on the IMP-16 chip set as early as 1972. The company reduced it to one chip called the Pace, and Bill Godbout Electronics announced a Pace-based computer, designed by George Morrow, in mid-1975. The unnamed system, a full-blown 16-bit computer with RAM and a built-in cassette interface, was advertised in the first issue of BYTE. They actually built one, but it never got to market. Bill Godbout said that the market wasn't ready for a 16-bit computer, and he was probably right. After all, the Altair was only a few months old itself. Neither the Pace chip nor the computer was ever a hit.

Other 16-bit chips included General Automation's LSI-16, a microprocessor version of its SPC-16 minicomputer; DEC's LSI-11, which was manufactured by Western Digital and included the PDP-11 instruction set; Western Digital's own WD-11, which was only one instruction different from the LSI-11; General Instrument's CP1600; and Texas Instruments'

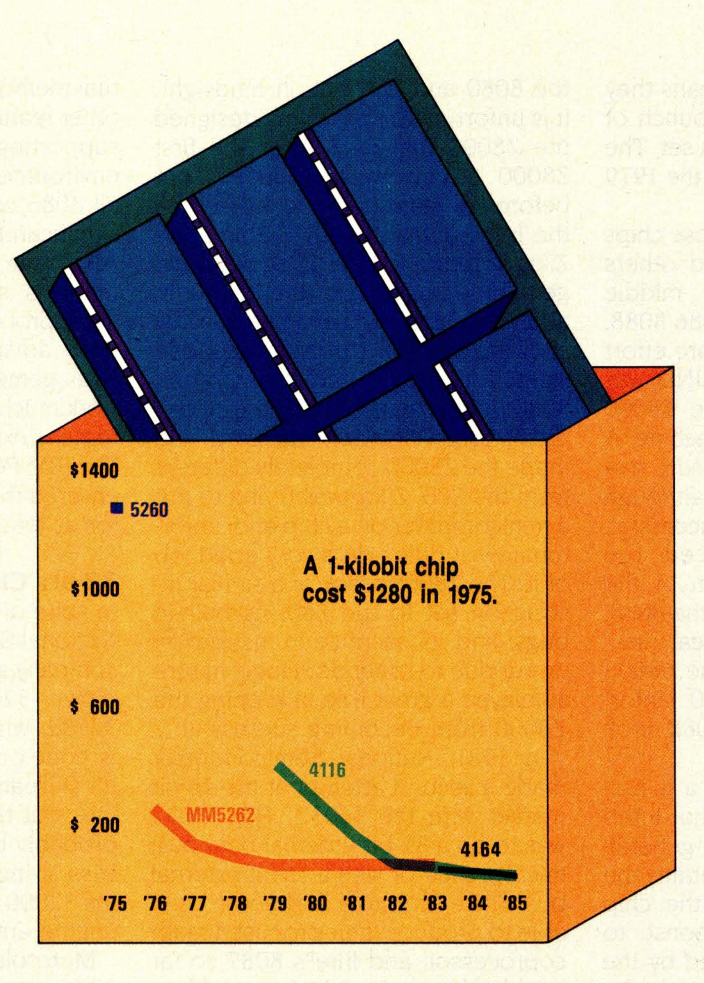
TMS9900, which went into their home computer, making it the first mass-market 16-bit computer.

Interestingly, the first literature released by MOS Technology on the 6502 showed some little dashed lines where the 16-bit extensions to their registers would go in their 16-bit version of the 6502, the 6516. But the 6516 was never marketed, and the little dashed lines soon disappeared. The existence of such a part was rumored for years, but it never surfaced. Not until December 1983 did the Western Design Center [not the same as Western Digital] announce a 16-bit version of the 6502.

Again, Intel needed something to compete with the Z80. The company figured that most previous 16-bit designs were flops because they had no existing software base that could easily be migrated to it—they were all the first microprocessor offerings from their respective companies.

But Intel had an edge: the growing base of 8080 software. The company decided that its 16-bit processor would be a direct enhancement of the 8080. In 1976 Intel started work on the 8086. Unfortunately, the designers did not preserve direct compatibilty with 8080 code, but at least each 8080 register had its 8086 counterpart, which made 8080-to-8086 code translators possible and gave programmers a familiar starting point. This was a big factor in the success of the 8086, which was announced to the world in 1978.

Then someone at Intel had an inspiration. Why not make the hardware almost as easy to migrate as the software? Thus was born the 8088. The 8088 is an 8086 on the inside but has



The cost of 64K bytes of RAM from 1975 to 1985, as found on the pages of BYTE magazine. Prices shown are for 512 of the 1-kilobit 5260 chip, 256 of the 2-kilobit MM5262 chip, 32 of the 2K-byte 4116 chip, and 8 of the 8K-byte 4164 chip.

an 8-bit data bus on the outside. When the processor wants to fetch 16 bits of data, it first gets 1 byte, then the second. The programmer doesn't have to worry about it, it all happens automatically in the hardware. The actual signals coming out of the 8088 look similar to the 8085, a chip that designers were already familiar with. Thus, it was easy to upgrade an existing 8-bit design to 16 bits.

You might think that by doing this the processor would run at half its potential. But Intel had been clever when they designed the 8086. Internally it consisted of two different but linked processors. One was the execution unit, the part that actually processes the data or executes the instructions. The other was called the bus-interface unit (BIU). The BIU handles all communications with the outside world and is in charge of generating addresses and storing and retrieving data from the system. Inside the BIU is a queue. While the execution unit is busy crunching data, the BIU is out on the bus getting the next instruction and putting it in the queue. The 8086 BIU can stay up to 6 bytes ahead of the execution unit by keeping those bytes in its queue. Because of the queue, the 8088 performance only suffers an average of 20 percent compared to an 8086. (See "Benchmarking the Intel 8086 and 8088" by Gregg Williams, July 1983 BYTE, page 147.) The 8086/8088 processors were the first to use a queue mechanism.

Intel also introduced another new concept with its 8086 family—coprocessing. The idea was to hang another processor right on the bus of the main processor to extend its functions. The most significant of these coprocessors was the 8087, a math coprocessor that added a whole set of floating-point instructions to the 8086/8088. Since the 8087 was built solely to do math, it could do so very quickly.

THE MC68000

In 1977, designers at Motorola were working on a new processor for the 16-bit market but vowing to keep it 32 bits internally. They also wanted to eliminate any special-purpose instructions and allow the processor to perform all operations, on all registers, on all data types, and in all addressing modes. This is called *orthogonality*. Programmers like

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BERGMAN HAKE DESIGN INC.

orthogonality because it means they don't have to memorize a bunch of exceptions to the instruction set. The fruit of Motorola's effort was the 1979 release of the MC68000.

The MC68000 is one of those chips that some people love and others hate. There is very little middle ground. Compared to the 8086/8088, it required a massive software effort to get it to do anything. But UNIX was becoming popular, and the 68000 looked like a good UNIX machine. A number of 68000-based UNIX machines were announced, although hardly any of them were successful.

Motorola also announced the 68008, an 8-bit-bus version of the 68000, similar in concept to the 8088. However, the 68000 had no real queuing, and that meant that the 68008 ran half as fast as the 68000. Unfortunately, this made the 8088 look even better.

Internally, the 68000 was a microcoded chip, which means that internal functional elements are general-purpose. A ROM (which contains the microcode) controls what the chip does. The processor's response to each instruction is controlled by the ROM. If an instruction doesn't do the right thing, you can usually fix it in the ROM and, within limits, you can even change the instruction set of the microprocessor if you want to. (IBM's add-in processor for the XT/370 is essentially a 68000 with custom microcode.)

Up until this time, all other processors were generally random-logic designs that had a little bit of circuitry to perform each specialized function within the central processor. There are advantages and disadvantages to both types of microprocessor design—microcoding offers flexibility at the expense of speed, while a random-logic design offers speed at the expense of flexibility. It is also difficult to fix errors in a random-logic design—especially when the designer of the chip leaves the company.

At Zilog, for example, Masatoshi Shima had begun work on a 16-bit processor, the Z8000, using random logic. Random logic worked fine for the 8080 and Z80 but, in hindsight, it is unfortunate that Shima designed the Z8000 that way. After the first Z8000 silicon was produced, but before his team had had worked all the bugs out of the chip, Shima left Zilog to return to Intel. Zilog never did get all the bugs out of the Z8000. In addition, Zilog had set a standard by allowing the Z80 to run all the software for the previous-generation 8080. Unfortunately, the company didn't follow its own standard and made the Z8000 completely different from the Z80. Zilog was trying to put a minicomputer on a chip and, unfortunately, it didn't do a very good job of it. The Z8000's lack of a similar instruction set to the Z80, its built-in bugs, and its sacrifice in instruction power due to its random-logic nature all played a great role in keeping the Z8000 from becoming successful.

In 1981, National Semiconductor made a second attempt at the 16-bit market with the 16032. The 16032 was to be a 32-bit (internal data bus) microprocessor with a 16-bit external bus. Since Motorola had never been able to produce their promised math coprocessor, and Intel's 8087 so far couldn't break the 5-MHz speed barrier, everyone was impressed when National announced its math coprocessor, which would run at 10 MHz, giving it twice the performance of Intel's 8087.

Unfortunately, National became the first microprocessor company to ship all its peripheral chips 100 percent functional before the processor was available. Today the 16032 still has a few bugs in it. But programmers like its instruction set, which reminds them of a VAX (a series of high-performance DEC superminicomputers). Because the VAX has been so successful as an engine for running UNIX, the 16032 may be a natural successor as the base for a UNIX computer. There may be some life left in it yet.

In 1982, Intel one-upped the semiconductor industry again. They announced the iAPX 286. This new product was a vastly upgraded 8086 architecture that included built-in virtual memory management and many other features designed expressly for supporting a multitasking, multiuser environment. It has a mode that runs all 8086 code directly, and Intel has significantly sped up its throughput. Also, true built-in memory management is something that no other microprocessor has to this day. The main advantage to having memory management built in is that it can work much faster than processors that require external memory managers. The IBM PC AT's use of the 80286 has ensured the success of this processor for at least the next few years.

32-BIT CHIPS

In spite of problems with the 16032, National Semiconductor was the first company to announce and ship a full-blown 32-bit microprocessor. The 32032, which used to be the 16032, is code-compatible with the 32016. It's still early to tell how the 32032 will fare, but the popularity of UNIX will probably be a major factor in its success, if indeed all the projections of the 32000 family being the ideal UNIX engine are true.

Motorola is now sampling its full 32-bit extension to the 68000, the 68020, which looks promising. It has one new feature that will probably get it into lots of designs early. Remember that the 8088 was successful because it allowed an easy migration path due to its 8-bit external data bus. The 68020 lets you dynamically choose the bus size you want—8, 16, or 32 bits. Supposedly, it is able to run all 68000 code, and it's fast. One of the things that gives it great speed is its cache—the logical extension of the queue used in the 8086/8088/80286 processors.

The cache in the 68020 is 256 bytes deep and works a little differently from a queue. If a jump occurs to a point in the queue, the queue is flushed and reloaded. But the cache looks just like memory, so a jump to a point in the cache would not cause the cache to be dumped and reloaded. If loops are small enough, they can execute directly from the cache. The advantage is that the pro-

cessor can access the cache much faster than it can access external memory, so programs run faster if they stay mostly in the cache. As with the 32032, it's still early to tell what the eventual success of the 68020 will be.

National has also announced the 32132 (not yet available), which is to have multiple caches and something the company calls a look-aside buffer.

Zilog had announced a product called the Z800, a 16-bit upgrade to the Z80 that was to be code-compatible with it. The company was never able to produce working silicon, however. Instead, it is trying to get the Z80 to work at 10 MHz. Zilog has also announced the Z80000, a 32-bit version of the Z8000 that I call the "kitchen-sink processor" because it will have everything, including code compatibility with the Z8000, which is the right idea but the wrong processor.

Intel has been talking for some time about the coming 80386, its 32-bit version of the 80286, but to date it hasn't released any hard data on it. Intel said it will be 80286-compatible, and that probably means IBM will use it.

The cost of an 8-inch single-sided double-density floppy-disk drive from 1977 to 1985. Note that such drives were not available in 1975 and 1976.

FASTER OR SMARTER?

I can't end my discussion of microprocessors without mentioning a few bizarre approaches. There is still a debate raging on whether microprocessor instruction sets should evolve toward more complex and high-level instructions, or whether they should be getting much simpler but much faster. So far, high-level instruction sets have not been winners. One ill-fated attempt was Western Digital's Pascal Microengine, which executed Pascal pseudocode (the output of all loyal Pascal compilers) directly. Unfortunately, Pascal compilers that put out native 8080 code beat it handily.

Similar in concept is the new FORTH processor from Novix, developed under the direction of FORTH inventor Charles Moore. Instead of executing the output of a compiler directly, this FORTH chip runs threaded FORTH code directly—its instruction set is FORTH. It's supposed to be very fast, and if you like FORTH it's great.

The FORTH engine is a custom version of a chip from National Cash Register called the NCR 32. It is a microcode-executing 32-bit engine on two chips; a third chip is required to contain the microcode. Essentially you can "roll your own" instruction set, which is what the developers of the FORTH engine did. This technique opens up a whole realm of possibilities, such as being able to emulate different computers on the fly by downloading different instruction sets. The speed at which this will be accomplished, however, will be limited by the fact that microcoding is hard work.

The Intel iAPX 432, probably the first 32-bit microprocessor available, was designed with very-high-level instructions to support the U.S. Department of Defense's Ada language.

Opposite the high-level instructions' team are those who think that a small set of simple but extremely fast instructions can outperform large and complex (slow) instructions. Such are the RISC (reduced instruction set computer) fans. A RISC machine was successfully implemented in silicon at Berkeley, amazingly on the first pass. They are currently working on speeding up the chip, which has a 32-bit architecture. Hewlett-Packard is also rumored to be working on several RISC machines.

Last is a unique device just about to be sampled from INMOS called the Transputer (see "The Transputer" by Paul Walker, May BYTE, page 219). It is designed to perform parallel processing. It will take many more years of software development and sophistication to take full advantage of the Transputer, but the possibilities are fascinating.

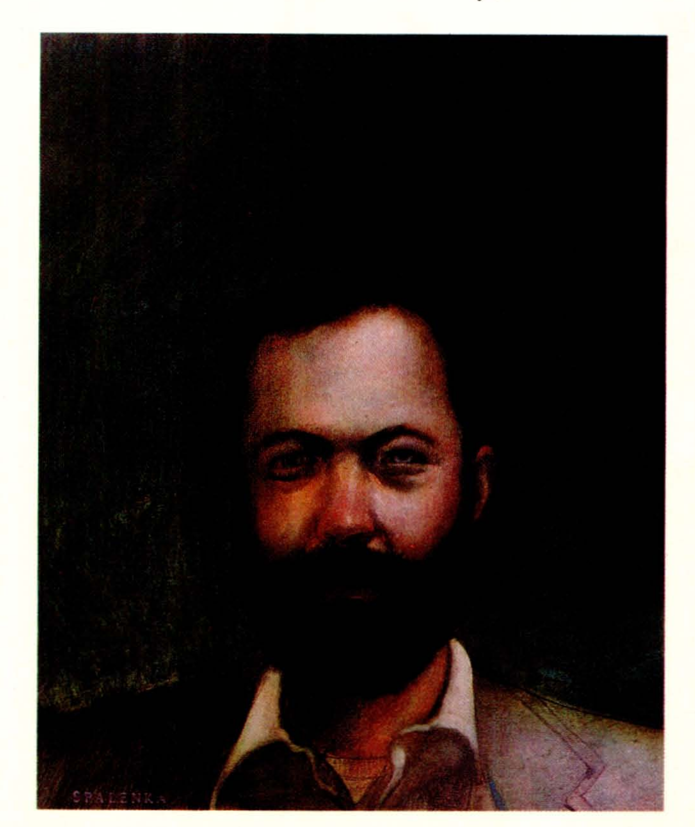
Meanwhile, a 4004 microprocessor still controls a traffic light near my office. It tends to put all the whizzy new things in perspective, doesn't it? ■

ACKNOWLEDGMENTS

I would like to thank Rebecca Wallo of Intel and Jim Farrell of Motorola for providing facts and figures for this article.

BERGMAN HAKE DESIGN INC.

INTERVIEW: Carl T. Helmers



Carl Helmers's interest in electronics began early. An amateur radio operator in high school, he put himself through the University of Rochester by learning FORTRAN, COBOL, *and* PL/I *(among other things), and writing programs for various companies. After graduating with a physics degree, Carl went to work for an aerospace company called Intermetrics and became a frequent traveler to* NASA's *Johnson Space Center in Houston. At* BYTE, *Carl introduced many outstanding writers to the* BYTE *readership, including Steve Ciarcia and Jerry Pournelle. Following his* BYTE *experience, Carl founded North American Technology Inc., which publishes* Bar Code News, Robotics Age, *and* Sensors *magazines in Peterborough, New Hampshire. He talked recently with* BYTE *editors Richard Shuford and Gregg Williams about how his interest and involvement with microcomputers developed.*

BYTE: *How did you get started in microcomputing?*
Helmers: In January of 1972 there was a presentation given in Houston by the executives of a new company in California called Intel. So I went and sat through a presentation about this wonderful thing called a microprocessor.

BYTE: *Was this the* 4004?
Helmers: The 4004 and the 8008. Actually, the 8008 was barely discussed, but it was the thing I zeroed in on. I knew that was going to be my computer. You see I had tried to design my own, but I had a problem deciding what the instructions were to be. Along came Intel with this little box and the company was going to hand me the instructions.

BYTE: *How did you get into publishing?*
Helmers: I sold 100 copies of a book on wire-wrapping. Then I started adding to my library publications of things that I could offer for sale. The longest was the *ECS Computer* publication, which was about a central processor based on the 8008. I published the 300 copies of the 72-page book in September 1974, and then I did it once a month thereafter. Since I was doing it once a month, I said, "Gee, this is a magazine, isn't it?" So I started calling it *ECS Magazine* in January of 1975.

BYTE: *How did* BYTE *come about?*
Helmers: Various people in Peterborough found out what I was doing. So I made a couple of trips to Peterborough in May 1975. We made the decision to publish BYTE at a meeting on May 25, 1975. That is the real birthdate of BYTE. Within a year and a half we had 50,000 subscribers.

BYTE: *What kind of magazine did you conceive* BYTE *to be?*
Helmers: I knew that I wanted a magazine that was the *Scientific American* of computer science with a vastly expanded amateur scientist section. That was my original conception, and the early years of BYTE were very much like that.

BYTE: *How did you find authors in those early days?*
Helmers: By publishing the magazine. For the first couple of issues I roped in acquaintances at Intermetrics, and I got my friends to write for us.

BYTE: *When did Robert Tinney enter the scene?*
Helmers: Robert is an old friend from my Houston days in the early 1970s. He did his first BYTE cover in December 1975. At the time he was constrained by our poverty to not using full color.

BYTE: *A number of projects stood out in the early days of* BYTE; *the* "LIFE Line" *series was one, the other was the infamous kludge harp.*
Helmers: The kludge harp was nothing more than a program to play music.

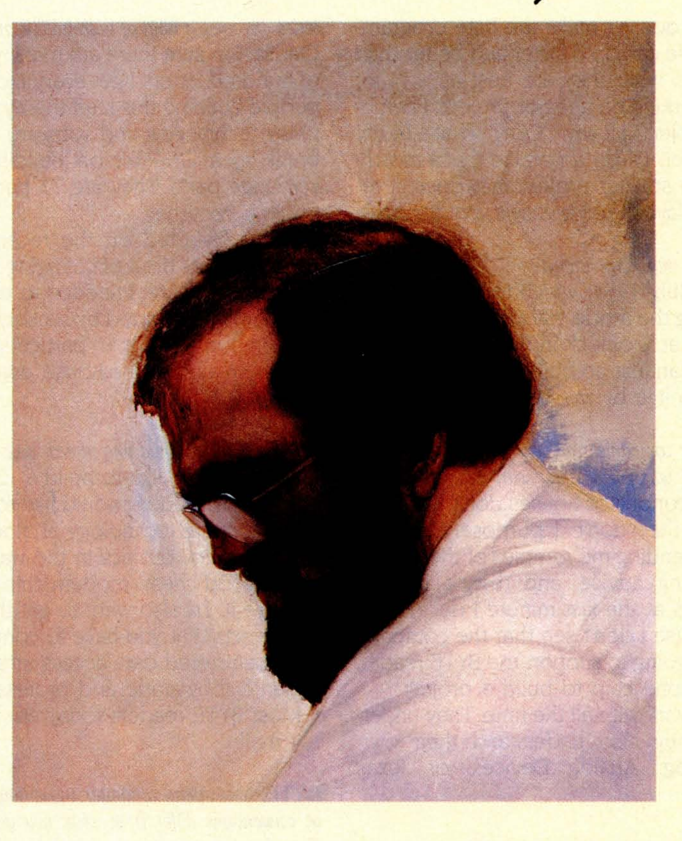
BYTE: *It was different in that, at the time, most people were looking at computers as blinking lights, at the very most. You had a peripheral, simple as it was, that allowed you to play music.*
Helmers: Actually, the reason I did that second 6800 system was to develop a 6800 that would control a music synthesizer. The other thing I did a lot of engineering on, early in BYTE, was this slow biphased Manchester-code audio-tape interface.

BYTE: *Are there any pioneers you'd particularly like to remember here?*
Helmers: Steve Jobs and Steve Wozniak. I think they are neat from several points of view. One is the naiveté they exhibited toward meeting magazines.

BYTE: *Is there anyone who has not received recognition that you think should have it?*
Helmers: Nat Wadsworth, a Scelbi computer consultant, who had the absolute first 8008 personal computer, and Lee Felsenstein, who started the Homebrew Computer Club. Then there are hundreds of authors who wrote for BYTE and other magazines. ■

PORTRAIT BY GREG SPALENKA

INTERVIEW: Steven A. Ciarcia



BYTE: *Steve, you are known for designing electronic and computer construction projects and writing about them. How did you get your start in this?*

Ciarcia: As far as electronics goes, I was just like any kid. When you're at a certain age, you find an electronic gadget and you want to see what's inside the box. So for years I had electronic parts lying all over the place at home. I never actually could afford to own a lot of equipment when I was a kid, so I had to build a lot of it.

Anyway, when I went to the University of Connecticut, I studied electrical engineering and came out with a BSEE. Then I worked in several engineering jobs.

In the early 1970s, while I was working for Control Data, I happened to see a construction article in *Radio Electronics* magazine about a thing called a "TV Typewriter," Don Lancaster's TVT-1. So I built that, and then I had the problem of "What do you do with this thing once you've got it?" Then a few months later, *Radio Electronics* ran another article, this one about building a small computer.

The project computer in the article was called the Mark 8. Jonathan Titus had designed it around the Intel 8008 microprocessor. I didn't want to build a Mark 8 because I felt its physical construction was hobby-grade. Having been involved in the electronics industry I knew what it took to make a computer stay reliable.

So I started hunting around for some other small computer that was also built around the Intel 8008. I found an outfit called Scelbi [pronounced "sell-bee"] Computer Consulting in Milford, Connecticut, that also made an 8008-based computer. I went down and saw Nat Wadsworth, the head of the company, and talked him into selling me his boards. I bought five blank circuit boards at $125 per board and populated them with my own chips. I ended up buying my 8008 for $120.

So after a while I had the Scelbi computer with the TVT-1 terminal tied onto it, a cassette recorder, a printer, a paper-tape reader—everything you could imagine back then. I homebrewed the cassette interface because Scelbi was using just paper-tape readers. By the time I retired the system a year and a half later, it had all of 4K bytes of memory in it and 4K bytes of EPROM. That was the first and last computer I wrote my own operating system for.

Next I got into graphics. I had bought a surplus Sanders Associates 708 terminal. This was actually built as an alphanumeric terminal, but it formed its characters by drawing vectors on the screen. I designed an interface and D/A converter driver to change the scanning so it would be a vector-graphics display, and I attached it to my 8008 system.

Having put together what I thought was a pretty neat graphics system, I thought somebody else might be interested in it, too. BYTE had been out for a couple of months by then, so I looked on the masthead and called up the editor, Carl Helmers. He liked the idea for an article. When the piece came out in November 1976, it got a very good response from the readers.

I then wrote a series of three articles that appeared in three consecutive months in 1977. After it turned out that these, too, were well received, I said to Carl, "Suppose I do articles regularly?" Carl still wasn't sure he could find anyone who could write for him on a deadline and instead asked me if I would be an editor and work for him on the magazine.

I didn't think I could do it. At the time I was working as a consultant to Pratt & Whitney in Hartford, where we built a computerized casting facility for jet-engine turbine blades. One of the Pratt people who worked with me was a guy who could write well and played the accordion. I told him about Carl's offer, and he went up to New Hampshire and took the job. That's how Chris Morgan, who later became editor in chief, came to BYTE.

I continued to do projects in my spare time and write them up for the magazine. From November 1977 to date, I've done an article a month.

BYTE: *How do you work on your projects?*

Ciarcia: There are two classes of projects, long-term and short-term, so there are two kinds of schedules.

To keep myself interested in the magazine articles, I have to do some really way-out projects each year. But I try to balance them by putting together some lower-level projects for those people who aren't ready for the big time.

A long-term project is essentially a significant computer product or system, like the home-control system I've been working on for about six months. [See Ciarcia's Circuit Cellar, April, May, and June.] Or I should say "*we've* been working on." On these big projects I have to have help. For instance, I have people who lay out printed-circuit boards for me. For anything that needs more than 100 lines of code, I hire a programmer to write it—that's the only

(continued)

PORTRAIT BY GREG SPALENKA

way I can get it done. But that doesn't make me hate programmers. It's just that somebody else can do it faster and better than I can. I think people should do what they are best at.

While all these people are working on a major project, I sometimes work on a short-term project. I'll say, "Okay, what's in my junk box that looks good?" Then I'll do an article that's mostly tutorial in nature or is about a smaller project that doesn't require an elaborate circuit-board layout and is easy to put together.

BYTE: *What's a good example of a short-term project?*
Ciarcia: The Whimsi-Bell from July 1984, which took about five days from conception to finishing the article. I stock common components in the Cellar so that if at 2 o'clock in the morning I get an idea about a good circuit I can just go build it. The inventory costs a lot, but it allows me to live by my own schedule.

BYTE: *Do people from semiconductor companies call you up and say, "Hey, I've got a wonderful new chip. Would you like to play with it?"*
Ciarcia: Yes and no. Most semiconductor houses don't have any way to get to me directly, so they don't. I purposely do that because I don't want anybody sending me samples of their products and giving me engineering advice, and then expecting something in return. Sometimes at the last minute I decide not to do a particular project because I don't see that the company that I have been dealing with is going to support the BYTE reader, who maybe wants to buy just one chip to build a project.

There are a few companies I work with all the time. They understand what I'm doing and they also understand their own business—companies like Zilog, Analog Devices, or Texas Instruments.

BYTE: *How do you handle working on many things at once?*
Ciarcia: You can't put together any kind of major project on a regular basis without having two or three running simultaneously.

Sometimes readers ask me why my construction designs show up on the market as commercial products. One reason is that it takes the resources only a company can provide to make the projects as useful as possible. Take the home-control system I wrote about for the April, May, and June issues this year. That had to be tested for radio-frequency interference by an independent lab to satisfy the FCC. Just that testing cost $5000. So by letting the system be put on the market, I enabled my readers to build a legal kit. And the companies can provide continuing support better than I can alone.

BYTE: *With that in mind, how do you regard your projects?*
Ciarcia: I think of them as what I personally want for toys, or to use myself.

There is one thing I want to make clear: My chief interest is in *designing* computers. If I have a special task for a computer to perform, I build a specialized system for it. I don't take one computer and try to do everything with it. For instance, the home-control system. I didn't take an IBM PC and write a 25,000-line program to make it control my home. I use an off-the-shelf computer only the way an average businessman would use it—for word processing, spreadsheets, and some other little stuff.

I designed the Trump Card because I didn't want to learn C or Pascal or mess around with assembly language. I knew BASIC. But BASIC was too slow—so I built a faster BASIC engine.

BYTE: *Do you think that reading about your projects, like the home-control series, becomes a kind of wish-fulfillment for people who tinker with electronics?*
Ciarcia: I'm sure there are many vicarious builders, but the couple of hundred letters I get every month indicate that there are more people building this stuff than you might think. There are a great many technicians and software guys out there that just want to break in a little bit on building hardware but don't want to scrounge parts. They are 75 percent of the people who put my projects together.

When I started on the recent home-control project, it was because I was tired of changing BASIC statements in the existing system every time I needed to turn on a light. I wanted a closed-loop system, triggered by sensor inputs, and money was no object. The motion sensors, in particular, cost a lot. But I ended up putting them all over the house, except in places where I didn't need them.

BYTE: *Have you had any project ideas that you haven't been able to complete?*
Ciarcia: Yes. I'd like to build a 1200-bit-per-second modem. And a lot of my readers would like to see me do that, too. The problem is that the technology of modems is changing so fast. It could be done now, but not in the way I'd want to do it. Even if I did find a good cheap modem chip, I'd want to have good software to drive it. I'd also want to get the modem FCC-tested—I'm tired of projects that you have to connect to a telephone line through an unregistered data-access arrangement. It's the difference between hobby-grade and professional-grade stuff.

Most BYTE readers today are not hobbyists—I know that from my mail.

BYTE: *You attend computer shows and conventions. Do the questions you get at conventions differ from what you get in letters?*
Ciarcia: I get more hobbyists at conventions, often high school students who are working on a science-fair project. The letters are frequently from business people or engineers.

I get between 200 and 250 letters every month. The majority of these are legitimate questions, and, unfortunately, it can take hours of research to find out the answers. I've had to hire seven people to help me answer letters. Even then we don't get to them all. We do try because the thousands of people whose letters we have answered over the years have become the greatest supporters of the Circuit Cellar. I've got hundreds of pictures from readers showing the projects they have built.

BYTE: *Do you think* BYTE *has had much effect on the development of personal computers?*
Ciarcia: BYTE was significant in being *essentially* the first in its field—I know you can argue about that—and in the formative years it stood out in its journalistic integrity: It supported the experimenter. It supported the new industry without trying to exaggerate its own value. It didn't work out any deals to trade advertising or good reviews for computer equipment. I picked up that same attitude when I began to write for BYTE.

BYTE: *Do you know of anybody who has picked up one of your ideas and made a successful commercial product out of it?*
Ciarcia: At the West Coast Computer Faire this spring, I found an exhibitor that had put together a computerized telephone message system, using the ADPCM (adaptive differential pulse-code modulation) speech-digitization scheme I described in June 1983. And there are a lot of my Z8 control computers out in the world that have been built into OEM products. ■

CIARCIA'S PRODIGIOUS OUTPUT

1976

Nov	Make Your Next Peripheral a Real Eye Opener (vector graphics)

1977

Mar	Try This Computer on for Size (review of Digital Group 8080A)
Apr	Having a "Private Affair" with Your Computer (humor)
May	Come Upstairs and Be Respectable (terminal communication)
Sep	Control the World! (Or at Least a Few Analog Points)

CIRCUIT CELLAR SERIES

1977

Nov	Memory-Mapped I/O
Dec	On a Test-Equipment Diet? Try an 8-Channel DVM Cocktail!

1978

Jan	Add More Zing to the Cocktail
Feb	A Penny-Pinching Address-State Analyzer
Mar	Program Your Next EROM in BASIC
Apr	Tune In and Turn On, Part 1: A Computerized Wireless AC Control System
May	Tune In and Turn On, Part 2: An AC Wireless Remote-Control System
June	Talk to Me: Add a Voice to Your Computer for $35
July	Build a Keyboard Function Decoder
Aug	Let Your Fingers Do the Talking: Add a Noncontact Touch Scanner
Sep	Let Your Fingers Do the Talking: Scanner Applications
Oct	No Power for Your Interfaces? Build a 5-watt DC-to-DC Converter
Nov	I've Got You in My Scanner! (light-source tracking)
Dec	Build an Octal/Hexadecimal Output Display

1979

Jan	Build a Computer-Controlled Security System for Your Home, Part 1
Feb	Build a Computer-Controlled Security System for Your Home, Part 2
Mar	Build a Computer-Controlled Security System for Your Home, Part 3
Apr	The Toy Store Begins at Home (Milton Bradley Simon game)
May	Communicate on a Light Beam
June	Mind Over Matter: Add Biofeedback Input to Your Computer
July	Sound Off! (SN76477 and AY-3-8910 sound effects)
Aug	Anyone Know the Real Time? (MM5312)
Sep	Joystick Interfaces
Oct	Self-Refreshing LED Graphics Display
Nov	The Intel 8086
Dec	Add Nonvolatile Memory to Your Computer (EAROM)

1980

Jan	Computerize a Home (BSR X-10 controller, the Busy Box)
Feb	A Computer-Controlled Wood Stove
Mar	Ease into 16-Bit Computing, Part 1: Get 16-Bit Performance from an 8-Bit Computer
Apr	Ease into 16-Bit Computing, Part 2: Examining a Small Multi-User System
May	I/O Expansion for the Radio Shack TRS-80, Part 1 (parallel ports)
June	I/O Expansion for the Radio Shack TRS-80, Part 2 (serial ports)
July	Handheld Remote Control for Your Computerized Home
Aug	A Build-It-Yourself Modem for Under $50
Sep	Build a Low-Cost, Remote Data-Entry Terminal
Oct	Make Liquid-Crystal Displays Work for You
Nov	Home In on the Range! An Ultrasonic Ranging System
Dec	Computerized Testing

1981

Jan	Electromagnetic Interference
Feb	A Computer-Controlled Tank (Milton Bradley Big Trak toy)
Mar	Build the Disk-80: Memory Expansion and Floppy-Disk Control
Apr	Build a Low-Cost Logic Analyzer
May	DC Motor Controls: Build a Motorized Platform
June	Build a Low-Cost Speech-Synthesizer Interface (Micromouth)
July	Build a Z8-Based Control Computer with BASIC, Part 1
Aug	Build a Z8-Based Control Computer with BASIC, Part 2
Sep	Build an Unlimited-Vocabulary Speech Synthesizer (SweetTalker)
Oct	Build an Intelligent EPROM Programmer
Nov	Switching Power Supplies: An Introduction
Dec	Build a Touch-Tone Decoder for Remote Control (ITT MSD3210)

1982

Jan	Analog Interfacing in the Real World (A/D conversion)
Feb	Build a Computerized Weather Station
Mar	Use Voiceprints to Analyze Speech
Apr	Use Infrared Communication for Remote Control
May	Everyone Can Know the Real Time (MM58167A)
June	Build an Interactive-Videodisc Controller
July	Add Programmable Sound Effects to Your Computer (SN76489A)
Aug	High-Resolution Sprite-Oriented Color Graphics (TMS9918)
Sep	Build the Microvox Text-to-Speech Synthesizer, Part 1: Hardware
Oct	Build the Microvox Text-to-Speech Synthesizer, Part 2: Software
Nov	Build the Circuit Cellar MPX-16 Computer System, Part 1
Dec	Build the Circuit Cellar MPX-16 Computer System, Part 2

1983

Jan	Build the Circuit Cellar MPX-16 Computer System, Part 3
Feb	Build a Hand-held LCD Terminal
Mar	Build the ECM-103, an Originate/Answer Modem
Apr	Build an RS-232C Breakout Box
May	Build an RS-232C Code-Activated Switch
June	Use ADPCM for Highly Intelligible Speech Synthesis
July	Build the RTC-4 Real-Time Controller
Aug	Build a Power-Line Carrier-Current Modem
Sep	Build the Micro D-Cam Solid-State Video Camera, Part 1
Oct	Build the Micro D-Cam Solid-State Video Camera, Part 2
Nov	Built the H-Com Handicapped Communicator
Dec	Keep Power-Line Pollution Out of Your Computer

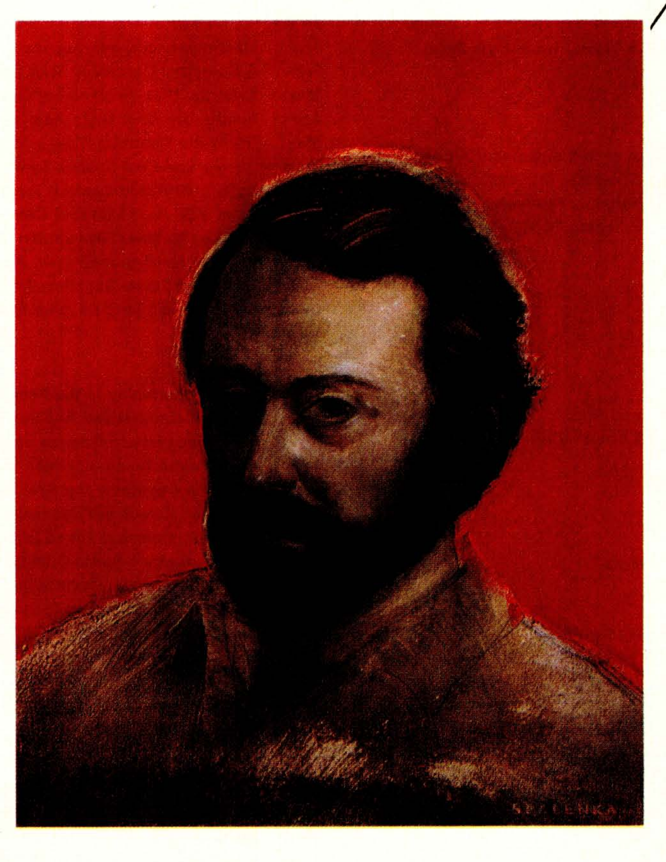
1984

Jan	Build the Term-Mite ST Smart Terminal, Part 1 (NS455)
Feb	Build the Term-Mite ST Smart Terminal, Part 2
Mar	Build a Third-Generation Phonetic Speech Synthesizer (SSI263)
Apr	Build a Scrolling Alphanumeric LED Display
May	Trump Card, Part 1: Hardware (Z8000 coprocessor for IBM PC)
June	Trump Card, Part 2: Software
July	A Musical Telephone Bell (AY-3-1350)
Aug	Circuit Cellar Feedback
Sep	Build the AC Power Monitor
Oct	An Ultrasonic Ranging System (SN28827)
Nov	The Lis'ner 1000 (SP1000 speech recognition)
Dec	Build the Power I/O System

1985

Jan	Understanding Linear Power Supplies
Feb	Build a Serial EPROM Programmer
Mar	Build the Touch-Tone Interactive Message System
Apr	Build the Home Run Control System, Part 1: Introduction
May	Build the Home Run Control System, Part 2: The Hardware
June	Build the Home Run Control System, Part 3: The Software
July	Living in a Sensible Environment
Aug	Build the BASIC-52 Computer/Controller

INTERVIEW: Robert T. Tinney



Artist Robert Tinney has provided most of the illustrations that have appeared on the cover of BYTE *during the past 10 years.*

Robert studied advertising art at Louisiana Tech and then began working in Houston, Texas, drawing and illustrating for various publishers and advertisers. A mutual friend introduced him to Carl Helmers, who at the time was working on software for NASA's space shuttle. The two became friends, and when Carl began at BYTE he called on Robert for illustrations.

Robert moonlighted on the BYTE *covers for the first few years, but in 1978 he moved to Baton Rouge, Louisiana, and began his computer-related illustrating full-time.*

BYTE *editors Richard Shuford and Gregg Williams talked with Robert about his 10-year association with the magazine and his thoughts about the future.*

BYTE: *How do you work with the* BYTE *editorial staff to develop ideas for cover art?*
Tinney: We almost always have an issue theme—a programming language, computer graphics, or whatever. We start with that. I try to get as much input from the editors as possible; many times they will have visual ideas. After that phase, I do several sketches and send them to BYTE. Sometimes the editors like a sketch immediately. If they don't, they make suggestions and I try again.

We start with the concepts and look for visual symbols to represent the concepts. Often the editors suggest these. To get the best effect you have to position or relate the symbols in unexpected, humorous ways.

BYTE: *Do you sometimes wish that computers and their parts looked more interesting?*
Tinney: Because computers mostly look like boxes with wires, I try to draw concepts rather than technical facts. I always try to create a separate three-dimensional reality that the reader feels drawn into. It may be a three-dimensional space that exists on one small part of a circuit board somewhere, or it may be floating in infinite space, but it still has three dimensions.

I want the person viewing the cover to be imagining himself doing whatever the activity is in the scene. I don't often show people on the cover having a third-person experience. I like to draw the reader into the experience.

BYTE: *What are you especially proud of?*
Tinney: I really liked the concept behind the February 1985 "Computing and the Sciences" cover, which had the ribbon cable and double-helix effect. There are other paintings, like the April 1984 issue, the "Real-World Interfacing" theme, which showed all the world spinning under control of a hand-held computer. Some readers didn't like that one, probably because its appeal was more visual than conceptual.

BYTE: *Do you personally own a computer?*
Tinney: It has been about a year and a half now since I got my first computer, a Morrow Micro Decision. It's very useful and I love it. It came with some bundled software. I use WordStar to do all my business correspondence. And I use Personal Pearl to keep track of a database of customers who have ordered BYTE cover reprints.

BYTE: *Can you tell us something about your explorations into computer-assisted drawing?*
Tinney: So far I've not used computer graphics for any cover work, but I hope to get into it because it's obviously going to be important.

BYTE: *Are you saying that as an illustrator or are you saying that as an illustrator who does computer-related themes?*
Tinney: Absolutely as an illustrator. Even as they stand today, computer graphics systems are to an artist what a word processor is to a novelist.

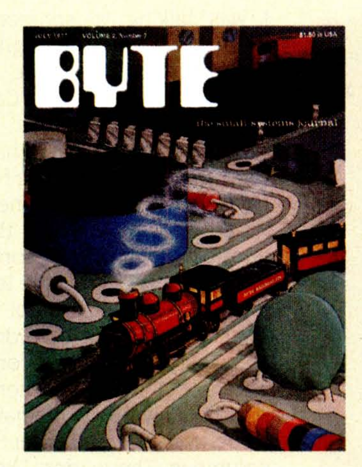
I'm sure that in the future a computer is going to be able to mimic a paintbrush, a pencil, charcoal, or pen and ink. It will be easier, better, and more expressive to use a digitizing tablet and pen than it will be to actually use a pencil or a paintbrush. The hardware and software have a long way to go before they get to the point that I am describing, but I believe that these capabilities are bound to come.

BYTE: *What computer graphics equipment have you used?*
Tinney: I've had very limited hands-on experience with a Time Arts Lumena system and an Artronics Artron Studio Computer. These might be described as mid-range systems, yet I was just amazed at their capabilities. They have reached the point where you can get one for what you would pay for an expensive automobile.

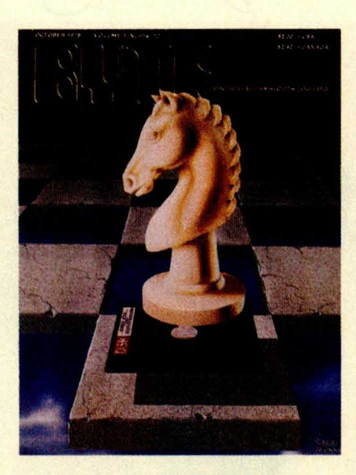
BYTE: BYTE *readers will be looking forward to seeing your work on the cover for years to come.* ■

 PORTRAIT BY GREG SPALENKA

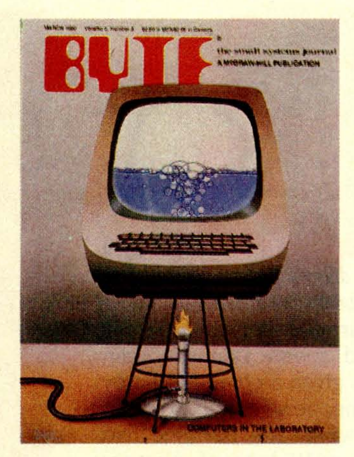
TINNEY FAVORITES



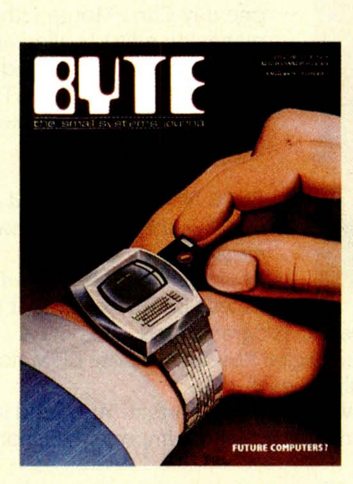
July 1977
Computer Engineering



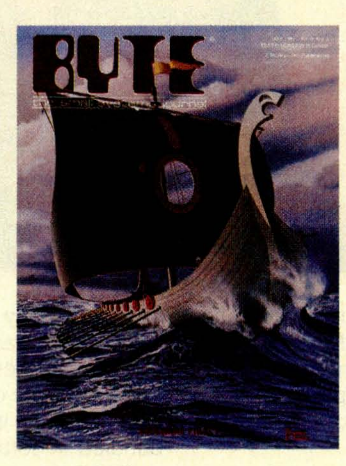
October 1978
Computer Chess



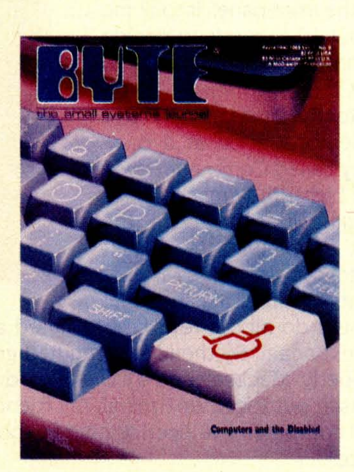
March 1980
Computers in the Laboratory



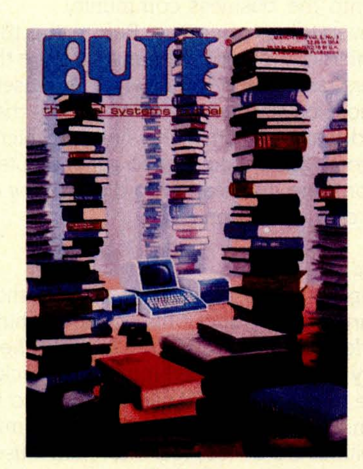
April 1981
Future Computers?



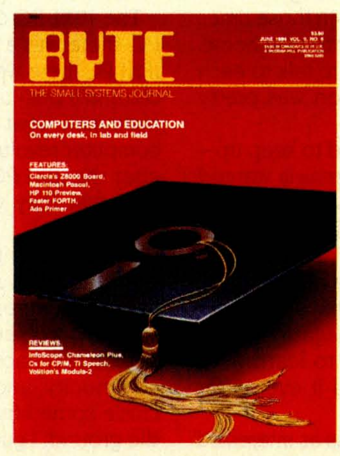
May 1981
Software Piracy



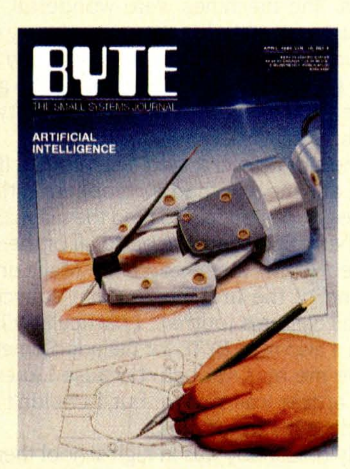
September 1982
Computers and the Handicapped



March 1983
The Stacks



June 1984
Graduation Memories



April 1985
Recursive Hands

BYTE COVERS PHOTOGRAPHED BY ED CRABTREE

INTERVIEW: Jerry Pournelle

BYTE: *Jerry, how did you first get involved with personal computers?*

Pournelle: Back in 1976 my mad friend Dan MacLean was given a computer kit by someone who couldn't get it to work. The machine had about 1K byte of memory and you programmed it by endlessly throwing switches on the front panel. It took me about 10 seconds to decide I wanted nothing to do with that thing.

Months later, though, I saw a demonstration at a company called Computer Power and Light. Their machine was running Electric Pencil, the first true full-screen text editor. It was love at first sight: I realized instantly that I could do all the revisions I wanted and never retype a page of text again. By then MacLean had got his old IMSAI working properly. MacLean and a Caltech graduate student named Tony Pietsch put together Ezekial, my friend who happened to be a Z80 computer. I've been writing my books with computers ever since.

BYTE: *How did you get involved with* BYTE?

Pournelle: Personal computers didn't work very well in the early days. The machines were wonderful, they'd do things I never thought possible, but they weren't very easy to use. In those times you couldn't just go to a store and buy a computer to take home. You got components and you tried to get them all to talk to each other, but they seldom did. The software situation was pretty grim, too.

The situation changed fast, though. If you wanted to keep up—and anyone who had a computer in those days *certainly* wanted to keep up—you had to read the magazines. There were a number of them, and I subscribed to all of them. I particularly recall one called ROM, the "Read-Only Magazine." It didn't survive.

One of the first magazines I subscribed to was BYTE—"The Small Systems Journal." I particularly liked the What's New section. I also read BYTE for the ads. Sometimes the magazine would drive me nuts, though, because I knew I wanted to learn what the article was saying, but I couldn't understand it even after reading it three times.

My oldest boy was in high school then and he was as interested in computers as I was. Sometime in the 1970s, after Ezekial came to live with me, my son Alex and I went to a computer show. I was talking to someone when Alex came over to grab me and said, "You have to come meet the fabulous Carl Helmers."

It turned out that Carl had read some of my science fiction, so we got along fine.

Carl and I discussed the possibility of my doing some articles for BYTE, but we left it pretty loose. Later I got to thinking about it. I didn't know very much about computers, but I did use them: Anything I wrote would have to be user-oriented. I sent a column in. The readers liked it. At first I just sent in columns when I felt like it, but one day Chris Morgan [then managing editor] called and said, "Your column is due next week." After that The User's Column became a regular feature in BYTE.

BYTE: *What milestones stand out in the history of the personal computer?*

Pournelle: Oh, let's see—Bill Gates's BASIC. Before that we didn't have any decent way to program small computers.

Then there was CP/M from Digital Research. Before CP/M none of our machines could talk to each other.

The Osborne computer was terribly important. You could just buy it and take it home and plug it in. More important, Osborne bundled in software.

dBASE II was the first really powerful database that ordinary people could learn to use on normal microcomputers. VisiCalc turned the Apple II into a viable business machine and introduced small computers into the business community.

The IBM PC changed everything, of course. Before the IBM PC, there was a definite microcomputer community. Before the IBM PC there were "hackers" and "users," and I wrote "the user's column"; but "users" in those days were still curious about their machines, what could be done with them, and where the microcomputer revolution was going. Many people who got computers after the IBM PC revolution were just users who didn't know or care that they were part of a revolution.

BYTE: *How has that changed your column?*

Pournelle: I'm still writing for the microcomputer user who's seriously interested in learning more about his or her machine. I guess my column is a little broader now: There's less out there for the real hacker, so I try to include something for the hacker community; and there are more occasional users, so I try to include something for them. Mostly, though, I write for the middle ground. I guess the column is a bit less technical than it used to be, which is strange, since The User's Column was supposed to be a nontechnical column in the first place. ■

PORTRAIT BY GREG SPALENKA

<u>*Low power*</u>

Complete hard disk kit $395

Comes complete with virtually the identical controller that's in the IBM® XT, and Xerox® warranties the hard disk for one year

Guaranteed 100 percent IBM PC compatible

How can we offer this fantastic price? Simple. We buy in such volume that even the most avaricious hard disk businessmen understand they have to give us the best price possible. We could pocket the difference, but we don't.

Instead, we put the extra profit into our testing facilities. That's why Xerox guarantees our $395 10 megabyte hard disk for one year.

Xerox knows, as our customers know, that we have an extensive testing program. Here is what we contribute toward giving you the maximum hard disk performance.

Best Drives Available

First, we buy the best drives available. Sounds trite, doesn't it? I mean, a drive's a drive—right? Hardly. You should see some of the junk we get in our labs. Some have such high failure rates that we even questioned our own $10,000 hard disk tester. But when we tested other manufacturers' drives we were assured that our equipment was fine, which just confirmed that the bad hard disks were not only bad—they were real bad.

But that's just the weeding out process. We then take each drive that we've put through our tester and test it again with the controller you've requested. We call this a "tested pair."

DOS Doesn't Do It

In case you're thinking that all this is an unnecessary duplication of what DOS does for you, let me explain the disk facts of life.

If DOS did what you may think it is supposed to do when you format the disk, DOS would map around these bad areas. Unfortunately, DOS doesn't do this.

DOS 2.0 and 2.1 can't enter the bad tracks. DOS 3.0 can, but only on the IBM AT. Unfortunately, as the press has so well documentated, the AT's hard disk develops bad tracks later on.

We do what DOS can't

We believe the problem is so bad, we use a software program that performs a powerful test of your disk drive on all of the IBM or IBM compatible computers—PCs, XTs, and ATs. Our format takes hours to analyze the disk. But when we finish, you know that the bad tracks are really mapped out so you won't write good data that will disappear into a black hole. We even send you a printed statement of our test results.

Our software allows you to type in the bad track locations from the list supplied by the manufacturers, so you'll never write good data to them—even if DOS didn't identify them as bad. The software even lets you save the location of these bad sections to a file, so that you can reformat your disk without spending hours retesting.

We even include a program that will give you continuous comments on the status of your hard disk. No more waiting for that catastrophic failure.

Average Access Time

As you might suspect, some hard disks are faster than others in their ability to move from one track of data to another. The time it takes the hard disk to move one-half way between the beginning of the disk to the end is called the "average access time."

The first generation of 10 megabyte hard disks had average access times of 80-85 milliseconds (msec). But computer users love speed, and guess what—the average access time for the new 20 megabyte hard disk in the IBM AT is only 40 msec. (We sell an AT equivalent with only 30 msec access time!)

There are some legitimate reasons for the shorter access time. It's particularly helpful when there are multiple users on the same hard disk. It's also important when running a compiler. But remember, before you get too wrapped up in the access speed, there's always that ST 506 interface which won't let data transfer from the hard disk to the computer any faster than 5 megabits/second. We've bypassed that choke hole, too. If you want the functional equivalent of a Ferrari with a turbocharger, order our 10 Mbit per second 100 megabyte hard disk with 18 mse of average access speed.

Compatibility

To be sure that your hard disk i 100 percent compatible with th IBM XT you don't need to bu the same hard disk that's in th XT. You can't even be sure wha brand hard disk it is becaus IBM, like Express Systems, goe into the marketplace and buy hard disks from several vendors However, they buy their X hard disk controller from onl one vendor—the same one w do.

You can buy the IBM XT con troller from IBM for $495 or yo can buy from us, the functiona equivalent, manufactured by th same company that makes it fo IBM for only $195. Is it the ex actly identical IBM XT control ler? No, it's better. First, it take less power, and secondly, it ca control from 5 to 32 mega bytes—the IBM controller ca work with only 10 megabytes. I is 100 percent IBM XT compati ble, and 100 percent is 100 per cent. If you want to save a slot we carry a version that lets yo operate two hard disks and tw floppy disk drives.

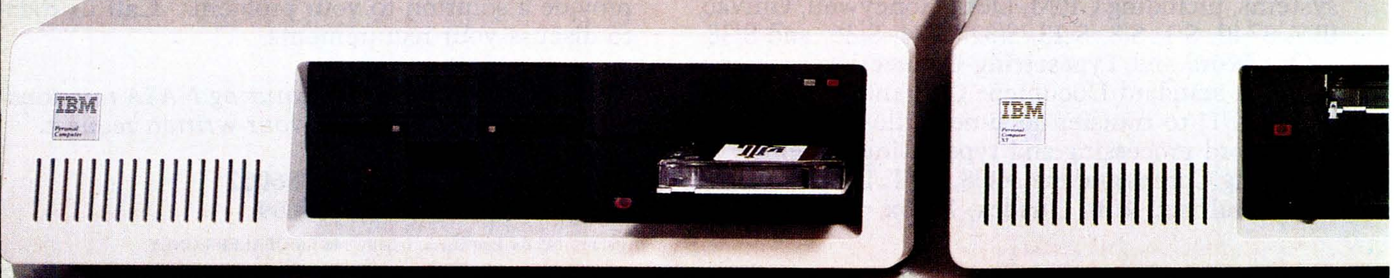
More than 32 Megabytes

You can operate with more tha 32 megabytes (the limit of DOS through the use of "device driv ers." Express Systems can suppl you with device drivers for ou hard disks for over 32 megabyte formatted. But, if you don't hav individual files, or databases tha are large, you might want to con sider one of our controllers tha can divide our 65 megabyat (formatted) hard disk into tw equal volumes of 32 megabyte each.

Reliability

We offer you a choice betwee iron oxide and plated media— the stuff that covers the har disk and gives it its magneti properties. Iron oxide is,—well it's rust. If you inadvertentl joust your disk, you may caus the low flying head to dig ou some iron oxide. A little rus flake can ruin your whole day Plated media is more resistant t damage, and if it happens, les data is lost.

We offer both types of har disks. The iron oxide is olde



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technology, and quite frankly, manufacturers understand it better. Their better understanding, combined with some of the special head locking mechanisms, gives us peace of mind when we sell you one.

Power

Hard disks consume power. Our small, half-high hard disks consume so little power that you can use them with your existing IBM PC power supply. If you plan to use lots of slots, you'll want to increase your power supply to be safe. We offer the same amount of power for your PC that comes in the XT.

Our Customers

Some folks just never feel comfortable buying mail order. They forget that Sears began as a mail order house or that IBM is now into mail order. But, if it helps, here is a *partial* list of customers who have felt comfortable to buy from us.

IBM	Sears
American Express	Honeywell
U.S. Army	MIT
AT&T (Bell Labs)	RCA
Bausch & Lomb	Lockheed
Xerox	Sperry

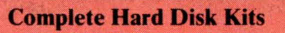
Easy to Install

If you're like most of us, raised on the boob tube rather than the Great Books, you'd rather see the movie than read the book. Well, now you can choose to read our installation manual or for only $9.95 more, you can get a VHS or Beta video cassette showing the simple steps for installation.



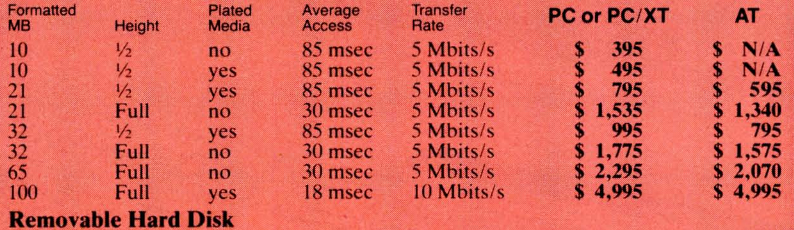
Warranty

We offer you a one year warranty on our hard disks—the same as IBM on the AT and 90 days on the tape drives. (It's all the manufacturer gives us.) If anything goes wrong with your tape or disk drive or hard disk, send it back in the box it came in. However, we have found that we can usually solve the problem over the phone. So call first for a return authorization number because we can't acccpt any returns without it.





Complete Hard Disk Kits



Formatted MB	Height	Plated Media	Average Access	Transfer Rate	PC or PC/XT	AT
10	½	no	85 msec	5 Mbits/s	$ 395	$ N/A
10	½	yes	85 msec	5 Mbits/s	$ 495	$ N/A
21	½	yes	85 msec	5 Mbits/s	$ 795	$ 595
21	Full	no	30 msec	5 Mbits/s	$ 1,535	$ 1,340
32	½	yes	85 msec	5 Mbits/s	$ 995	$ 795
32	Full	no	30 msec	5 Mbits/s	$ 1,775	$ 1,575
65	Full	no	30 msec	5 Mbits/s	$ 2,295	$ 2,070
100	Full	yes	18 msec	10 Mbits/s	$ 4,995	$ 4,995

Removable Hard Disk

Formatted MB	Height	Plated Media	Average Access	Transfer Rate	PC or PC/XT	AT
10	½	no	90 msec	5 Mbits/s	$ 1,095	N/A



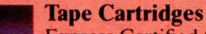
Tape Systems and Subsystems



Formatted Storage Capacity	Height	Data Transfer Rate (k/sec)	PC or PC/XT	AT
60 Mbytes	½	88	$ 995	$ 995
60 Mbytes Subsystem		88	$ 1,295	$ 1,295
21 Mbytes (unformatted) Start/stop Subsystem		24	$ 595	$ 595
26 Mbytes Floppy Tape® Subsystem		31	$ 749	$ 749

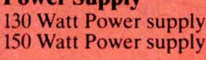
Controllers

All of our hard disk and tape controllers are available separately: Please call for prices.



Subsystem Chassis

Any of our disk or tape units are available in an external subsystem for an additional $250.00. You can mix & match any of our ½ high hard disks or tape drives together or add any single full height hard disk.





Tape Cartridges

Express Certified 555 foot 310 Hci ¼-inch Data Cartridge — $35.00

Power Supply

130 Watt Power supply — $75.00*

150 Watt Power supply — $125.00

*with the purchase of any drive

Comes complete

All Express Systems products come complete with the appropriate software, tape and/or hard disk controllers, and cables where required. Hard disks are formatted and tested with the PC DOS of your choice. All drive sizes are formatted capacities.

If your application requires a stacking kit, power splitter cables, daisy chain cable, or some other variation, we'll supply these items at a nominal charge. We even ship our hard disks with Command Assist™ an on-line DOS-like manual to give you help with your DOS commands.

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Because we spend so much attention on the front end with ensuring that our disks will arrive in working order, we have a customer service department that, unlike many of our competitors, has little to do. When you need us, you won't get a constant busy signal.

Call our friendly, knowledgable customer service staff to get answers to your questions—before or after the sale. Our people, who know the PC, can talk you through the sticky parts, and they'll respond to you quickly. Just call us.

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Pick up the telephone and call 1-800-341-7549, to order. We accept Master Card, VISA, American Express and Diners Club. Or send a cashier's check or









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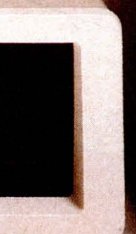
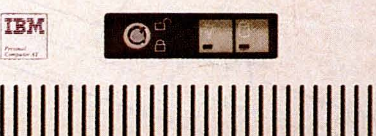


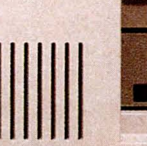
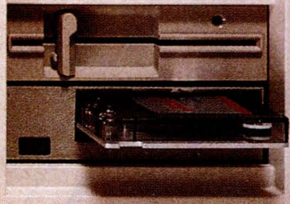
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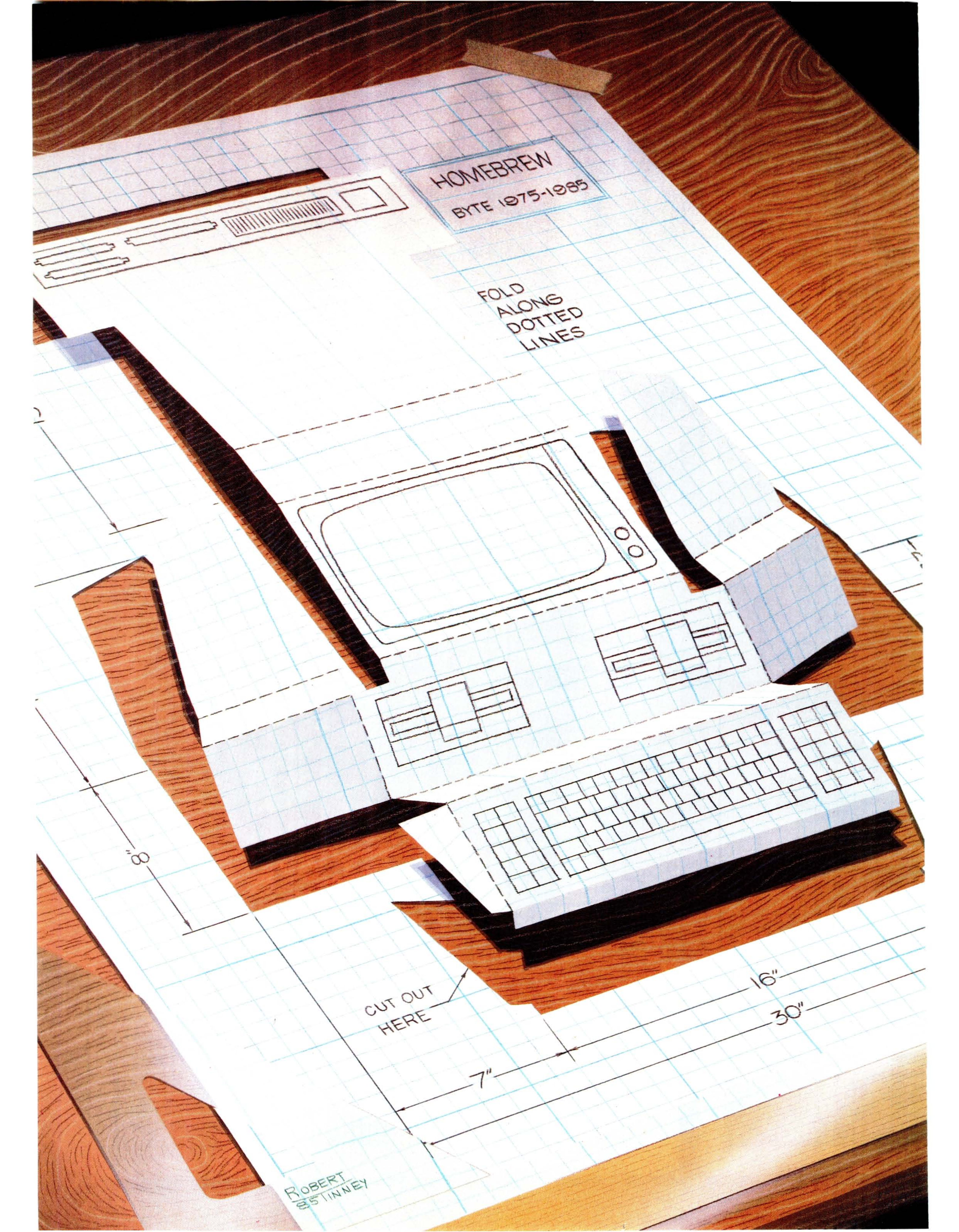
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ROBERT
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Homebrewing

IN THE PAST, THE ONLY WAY you could get hardware for your computer system was to build it yourself. Today, you can get almost anything you might want for your computer, but for a price. Many people are interested in hardware projects not only because they are an inexpensive source of extensions to their systems but also because of the experience they gain by building these projects.

We have several construction projects this month, ranging from the simple to the complex. In his article "The Quarter-Meg Atari 800XL," Claus Buchholz details how to upgrade your Atari 800XL memory to 512K bytes and promises to free users from the slow Atari disk-drive access time by providing software for implementing a fast RAM disk that uses all the extra memory.

Today, many computers have a Centronics parallel printer port as standard equipment. If you happen to have a serial printer, your parallel port may go unused. Howard Austerlitz presents an inexpensive parallel-to-serial printer port adapter that will help you take advantage of your parallel ports.

Often, the main thing separating an $8000 commercial word processor from a word-processing program on a microcomputer is the presence of predefined keys for special functions on the dedicated systems. While most newer microcomputers have 10 or 12 programmable function keys, many older machines don't. Mark Hanslip has designed a project that enables you to add up to 40 function keys to any microcomputer with a parallel-encoded keyboard.

And for the ambitious builder, Clifford Kelley's two-part article "EGO: A Homebuilt CPU" (to be continued next month) delves into the complexities of building your own microprocessor: designing the instruction set, system architecture, and system hardware. While you may not want to build your own microprocessor, you'll probably be interested in the considerations that go into designing such a complex system.

Finally, be sure to check out Ciarcia's Circuit Cellar this month. Steve presents the SB180, a high-performance, HD64180-based, Z80-compatible single-board computer kit with 256K bytes of memory; floppy-disk controller; one I/O, one parallel, and two serial ports; and a lot of software. Don't let its 8-bit microprocessor fool you; the 6-MHz SB180 turns in some impressive benchmarks.

EGO: A HOMEBUILT CPU

PART 1: THE SOFTWARE

BY CLIFFORD KELLEY

This homemade CPU *sports a clever instruction set*

Editor's note: Part 1 of this two-part series covers the instruction set and software aspects of the EGO *computer. Next month the author will examine the* EGO *computer's hardware.*

IT IS DIFFICULT TO JUSTIFY building a custom CPU (central processing unit). It won't cost less than an available microcomputer; it will take many hours to design, build, and debug; and, most important, no software will be available for it. However, there are the advantages of being able to incorporate features not found on commercial processors, not to mention the education you would derive from undertaking such a project.

For many years I toyed with the idea of building a CPU. I studied the subject briefly, but reality intruded and I soon forgot it. Then, a few years ago, I took some digital design courses that finally gave me the confidence to determine what my budget could take and to get on with it.

First, I set about defining the requirements. There were only two: Make it simple and make it powerful enough to be useful. These are somewhat contradictory, but in the end I believe EGO fulfilled both.

THE INSTRUCTION SET

The most important part of designing a computer is devising the instruction set. It is the major determinant of the system architecture. As I said, I wanted EGO to be simple yet useful. My definition of useful is the ability to do floating-point operations efficiently. Thus, defining the ALU (arithmetic logic unit) operations was my first step. I wanted the ALU to be able to load, shift, rotate, increment, decrement, add, and subtract at the very least. These, combined with some simple logic operations like AND, OR, and exclusive-OR, gave me a list of 14 instructions. The 74381 4-bit ALU seemed the perfect device. I could use it for the logic and arithmetic instructions. This left me with 16 basic instructions taking up 4 bits of instruction space.

Next came the instruction types. These determine how an instruction defines where the data used by the ALU comes from and where the results will be stored. In order to keep the instruction set simple, I decided to keep all EGO's registers general-purpose. Consequently, there are no restrictions on which registers can be used in what instructions, and the only special-purpose register is register 0, which is used as the program counter. Although I could have constructed an instruction set that loaded data directly to and from memory locations (known on most processors as direct addressing), I felt this would slow down the computer and corner me into including two or three memory-pointing registers (like the HL register pair on the 8080 or the SI and DI registers on the 8088/86) manipulated by a number of special instructions. The only reasonable solution was a large number of general-purpose registers that programmers could dedicate as their needs required. This also forced me to design EGO so that registers could be used for direct addressing (in which the register holds the actual data) as well as indirect addressing (in which the register holds the address of the data).

I decided that EGO would have four different instruc-

(continued)

Clifford Kelley has a B.S. in physics and mathematics from Marquette University. He currently works on missile simulation systems at Rockwell International. He can be contacted at 4127½ Maybank, Lakewood, CA 90712.

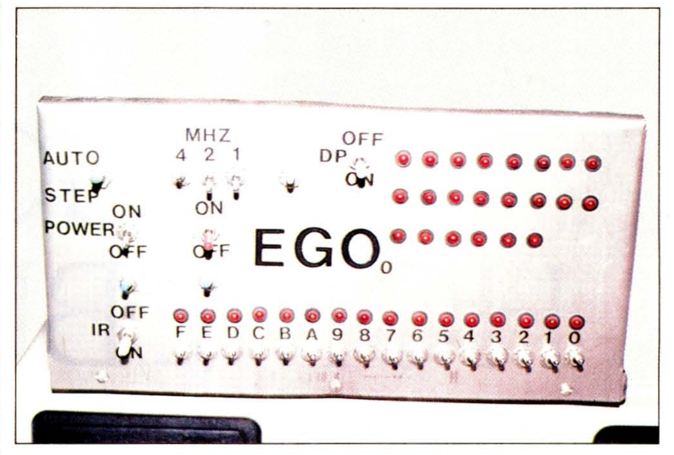


Photo 1: EGO, *the author's homemade* CPU, *sits atop a* Tandy 2000 *that is used for uploading and downloading programs. The switch in the upper left corner allows the author to run* EGO *in single-step mode, and the row of* LEDs *along the bottom can be used to read either* EGO*'s data bus or the* CPU*'s instruction register.*

tion types: data, register, indirect operand, and indirect result. The data instruction type (often referred to on other processors as the "immediate" instruction type) is composed of two words; the first word holds the instruction, and the second is data. The operation is performed using the data word and the contents of a register, and the result is returned to the register.

All other instruction types require only one word. In the register instruction type, the operands are the contents of two registers, and the result is stored in one of the registers. Indirect operand instructions use the contents of a register as one operand, use the contents of another register as a memory address where the other operand is stored, and leave the result in a register. Finally, the indirect result instruction type functions like the indirect operand type, except that the result is returned to the memory address of the second operand.

The last major decision was how long the instruction word and address lengths would be. Actually, it was an easy decision. To be useful, EGO had to be able to address a large amount of memory; to keep the registers truly general, the instruction length must be the same as the address length. For the address length, I felt the standard 16 bits would be more than adequate. Since EGO would be addressing words, this would give me a total of 64K words, or 128K bytes of memory—twice that available on 8-bit microprocessors. The instruction length is also a multiple of 4, which would make the circuits easier to build and allow 10 bits for register addressing. I felt that a two-address instruction set was a minimum for keeping the instructions general. I would have preferred a three-address instruction set, but that would have left me with only enough bits in the instruction to address eight reg-

(continued)

AMAZING DAISY

NOW! FULL SIZE, FULL FEATURE, LETTER QUALITY AT ONLY $353

If you have been searching for a letter quality printer you have probably found the flood of claims and counterclaims to be a real roadblock in your search. Not long ago we were in the same position. We tried to determine which daisy wheel printer had all the features our customers wanted, yet would not set them back a month's salary. Recently several manufacturers have introduced machines that had features we were seaching for. After a thorough assessment, we eliminated one model after the other for lack of one feature or another until we only had one left.

THE RESULTS ARE IN

We found the printer which has all the features anyone could want. The winner is the Aprotek Daisy 1120, a real heavy-duty workhorse printing at 20 characters per second. The manufacturer is Olympic Co. Ltd., a highly respected Japanese firm.

FEATURES GALORE

This printer has it all. To start with, it has a front panel Pitch Selector button with indicators which allows 10, 12, 15 characters per inch (CPI) or Proportional Spacing. There is a Select (Online) button (with indicator) and a Line Feed button. You can also set Top-of-Form or Form Feed with the touch of the TOF button. Other front panel indicators include Power and Alarm.

To load a sheet of paper, simply place it in the feed slot and pull the paper bail lever. PRESTO! The paper feeds automatically to a 1 inch top margin and the carriage aligns to the selected left margin. In this manner, each page can have identical margins automatically. You can continue to compute while the Daisy 1120 is printing. The built in 2K buffer frees up your computer while printing a page or two allowing you to go to your next job.

To really put your printer to work, the Cut Sheet Feeder option is great for automatic printing of those long jobs. Also available is the adjustable Tractor Feed option. Compare our option prices! Best of all the Daisy 1120 is quiet: only 57 dB-A (compare with an average of 62-65 dB-A for others).

COMPLETE COMPATIBILITY

The Daisy 1120 uses industry standard Diablo® compatible printwheels. Scores of typeface styles are available at most computer or stationary stores. You can pop in a 10, 12, 15 pitch or proportional printwheel and use paper as wide as 14". At 15 CPI you can print 165 columns—great for spreadsheets.

The Daisy 1120 uses the Diablo Hytype II® standard ribbon cartridges. Again universally available.

Not only is the hardware completely compatible, the control codes recognized by the Daisy 1120 are Diablo 630® compatible (industry standard). You can take advantage of all the great features of word processing packages like Wordstar®, pfs: Write®, Microsoft Word® and most others which allow you to automatically use superscripts, subscripts, automatic underlining, boldface (shadow printing) and doublestrike.

The printer has a set of rear switches which allow the use of standard ASCII as well as foreign character printwheels. Page length can be set to 8, 11, 12, or 15". The Daisy 1120 can also be switched to add automatic line feed if required.

THE BEST PART

When shopping for a daisy wheel printer with all these features (if you could find one), you could expect to pay $600 or $700 dollars. The options would add much more. *Not now!* We have done our homework. We can now offer this printer for only $353. Order yours today!

NO RISK OFFER

Try the Daisy 1120 for 2 weeks. If you are not satisfied for ANY reason we will refund the full price—promptly. A full 1-year parts and labor warranty is included.

THE BOTTOM LINE

Aprotek Daisy 1120 (Order#1120) $353 w/standard Centronics parallel interface and 2K buffer.

Options

Auto Cut Sheet Feeder (#1110) $188
Tractor Feed (#1112) $77

Accessories

8' Cable for IBM PC® and compatibles (#1103) $26

Interface with cable: •TI-99/4A (#106) $66
•Apple II or IIe (#1104) $76
•All Commodore (except Pet) (#1105) $44
•All Atari (#1107) $66

Shipping is $11—UPS continental USA. If you are in a hurry, UPS Blue or Air Parcel Post (second day air) is $25. Canada, Alaska, Mexico and Hawaii are $30 (air). Other foreign is $60 (air). California residents add 6% tax. Prices are cash prices—VISA and M/C add 3% to total. We ship promptly on money orders, cashier's checks, and charge cards. Allow 14-day clearing for checks. No C.O.D.'s. Payment in US dollars only.

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APROTEK
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EGO Instruction Set

15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0	bit number
: 0 : 0 : Op Code : 1 : Condition : S2 :	Word 1
15 0	bit number
: Data :	Word 2

The condition bits refer to the four condition flags that are stored after every ALU operation:

Bit #	Flag	Set condition
8	Z	ALU result is zero
7	N	ALU result is negative
6	P	ALU result is positive
5	C	ALU result overflows (carry)

Operation Code	Operation	Mnemonic
0 0 0 0	S2 = Data	LD S2,#Data ****
0 0 0 1	S2 = Data + 1	INC S2,#Data ****
0 0 1 0	S2 = S2 − Data	SUB S2,#Data ****
0 0 1 1	S2 = S2 − Data − $\overline{cy}$	SBC S2,#Data ****
0 1 0 0	S2 = Data − S2	NAD S2,#Data ****
0 1 0 1	S2 = Data − S2 − $\overline{cy}$	NCA S2,#Data ****
0 1 1 0	S2 = Data + S2	ADD S2,#Data ****
0 1 1 1	S2 = Data + S2 + cy	ADC S2,#Data ****
1 0 0 0	S2 = Data xor S2	XOR S2,#Data ****
1 0 0 1	S2 = Data left shift	SL S2,#Data ****
1 0 1 0	S2 = Data or S2	OR S2,#Data ****
1 0 1 1	S2 = Data left rotate	RL S2,#Data ****
1 1 0 0	S2 = Data and S2	AND S2,#Data ****
1 1 0 1	S2 = Data − 1	DEC S2,#Data ****
1 1 1 0	S2 = Data right shift	SR S2,#Data ****
1 1 1 1	S2 = Data right rotate	RR S2,#Data ****

The **** is space for the condition mnemonic code.

Figure 1: *Data instruction types. These are the two-word instructions; all other instructions take only one word.*

isters—not enough registers to allow for both dedicated uses and scratch-pad space for floating-point operations. A two-address instruction set allowed 5 bits to address a register, for a total of 32 registers, which appeared to be more than enough to do the job.

Inevitably, I had to make some compromises in the design of the instruction set. The data instruction type was necessary to load constants into registers. Since I made the program counter part of the general register set and was able to set aside 4 bits in the data type instruction word for condition testing, EGO could perform conditional jumps. This was in keeping with the general ALU structure I had chosen, but some miscellaneous instructions,

(continued)

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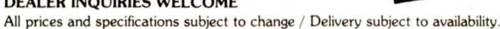
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Condition Code

Condition Bits	Execution Condition	Mnemonic
0 0 0 0	Not carry	I
0 0 0 1	Carry	C
0 0 1 0	Greater than 0	P
0 0 1 1	Greater than 0 or carry	CP
0 1 0 0	Less than 0	N
0 1 0 1	Less than 0 or carry	CN
0 1 1 0	Not 0	PN
0 1 1 1	Not 0 or carry	CPN
1 0 0 0	Equal to 0	Z
1 0 0 1	Equal to 0 or carry	CZ
1 0 1 0	Greater than or equal to 0	PZ
1 0 1 1	Greater than or equal to 0 or carry	CPZ
1 1 0 0	Less than or equal to 0	ZN
1 1 0 1	Less than or equal to 0 or carry	CNZ
1 1 1 0	Unconditional	'blank'
1 1 1 1	Unconditional	'blank'

Figure 2: *Bit settings for condition-flag testing. If the condition is not met, then execution continues with the instruction following the data word.*

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	bit number
0	0	0	0	0	0	0	Operation Code									

Operation Code	Operation	Mnemonic
0 0 0 0 0 0 0 0 0	No operation	NOP
0 0 0 0 0 0 0 0 1	Set carry flag	SCF
0 0 0 0 0 0 0 1 0	Clear carry flag	CCF
0 0 0 0 0 0 0 1 1	Halt	HLT

Figure 3: EGO's *miscellaneous instructions.*

such as set carry, clear carry, halt, and no-operation, are also useful. Fortunately, there was 1 bit left to distinguish between data and miscellaneous instructions.

Thus the instruction set is small but very general. Figures 1 through 5 summarize the instruction set. Bits 15 and 14 hold the instruction type. Bits 13 through 10 determine the operation performed. The two-address instructions (figures 3, 4, and 5) allow one operand from S1 (source 1) and the other from S2 (source 2). It is assumed that the result will be sent to S2. When only one operand is required, S1 is the operand and S2 is the location in which the result is stored. Except for the data instructions, the last 10 bits are divided into two groups: bits 9 through 5 for S1 and bits 4 through 0 for S2.

The first and most complex of the instruction types is

(continued)

EGO

15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 bit number

: 0 : 1 : Op Code : S1 : S2 :

Operation Code	Operation	Mnemonic
0 0 0 0	S2 = S1	LD S2,S1
0 0 0 1	S2 = S1 + 1	INC S2,S1
0 0 1 0	S2 = S2 − S1	SUB S2,S1
0 0 1 1	S2 = S2 − S1 − $\overline{cy}$	SBC S2,S1
0 1 0 0	S2 = S1 − S2	NAD S2,S1
0 1 0 1	S2 = S1 − S2 − $\overline{cy}$	NCA S2,S1
0 1 1 0	S2 = S1 + S2	ADD S2,S1
0 1 1 1	S2 = S1 + S2 + cy	ADC S2,S1
1 0 0 0	S2 = S1 xor S2	XOR S2,S1
1 0 0 1	S2 = S1 left shift	SL S2,S1
1 0 1 0	S2 = S1 or S2	OR S2,S1
1 0 1 1	S2 = S1 left rotate	RL S2,S1
1 1 0 0	S2 = S1 and S2	AND S2,S1
1 1 0 1	S2 = S1 − 1	DEC S2,S1
1 1 1 0	S2 = S1 right shift	SR S2,S1
1 1 1 1	S2 = S1 right rotate	RR S2,S1

Figure 4: EGO's *register instructions.*

15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 bit number

: 1 : 0 : Op Code : S1 : S2 :

Operation Code	Operation	Mnemonic
0 0 0 0	S2 = (S1)	LD S2,(S1)
0 0 0 1	S2 = (S1) + 1	INC S2,(S1)
0 0 1 0	S2 = S2 − (S1)	SUB S2,(S1)
0 0 1 1	S2 = S2 − (S1) − $\overline{cy}$	SBC S2,(S1)
0 1 0 0	S2 = (S1) − S2	NAD S2,(S1)
0 1 0 1	S2 = (S1) − S2 − $\overline{cy}$	NCA S2,(S1)
0 1 1 0	S2 = (S1) + S2	ADD S2,(S1)
0 1 1 1	S2 = (S1) + S2 + cy	ADC S2,(S1)
1 0 0 0	S2 = (S1) xor S2	XOR S2,(S1)
1 0 0 1	S2 = (S1) left shift	SL S2,(S1)
1 0 1 0	S2 = (S1) or S2	OR S2,(S1)
1 0 1 1	S2 = (S1) left rotate	RL S2,(S1)
1 1 0 0	S2 = (S1) and S2	AND S2,(S1)
1 1 0 1	S2 = (S1) − 1	DEC S2,(S1)
1 1 1 0	S2 = (S1) right shift	SR S2,(S1)
1 1 1 1	S2 = (S1) right rotate	RR S2,(S1)

Figure 5: EGO's *indirect operand instructions.*

data (figure 1). Since only one register is referenced, there is room in the instruction for condition testing. Four condition flags are used to indicate the result of the previous ALU operation: zero, negative, positive, and carry (overflow). These can be tested in any combination, but you will notice that the "no flags" condition is used to test for "not carry" generated (see figure 2). If the condition is not met, the data instruction is ignored and execution con-

(continued)

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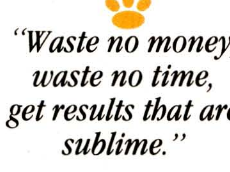
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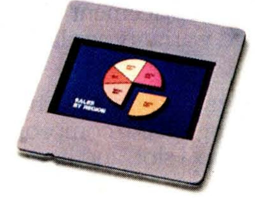




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15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	bit number
1	1	Op Code				S1						S2				

Operation Code	Operation	Mnen
0 0 0 0	(S2) = S1	LD
0 0 0 1	(S2) = S1 + 1	INC
0 0 1 0	(S2) = (S2) − S1	SUB (S2),S1
0 0 1 1	(S2) = (S2) − S1 − $\overline{cy}$	SBC (S2),S1
0 1 0 0	(S2) = S1 − (S2)	NAD (S2),S1
0 1 0 1	(S2) = S1 − (S2) − $\overline{cy}$	NCA (S2),S1
0 1 1 0	(S2) = S1 + (S2)	ADD (S2),S1
0 1 1 1	(S2) = S1 + (S2) + cy	ADC (S2),S1
1 0 0 0	(S2) = S1 xor (S2)	XOR (S2),S1
1 0 0 1	(S2) = S1 left shift	SL (S2),S1
1 0 1 0	(S2) = S1 or (S2)	OR (S2),S1
1 0 1 1	(S2) = S1 left rotate	RL (S2),S1
1 1 0 0	(S2) = S1 and (S2)	AND (S2),S1
1 1 0 1	(S2) = S1 − 1	DEC (S2),S1
1 1 1 0	(S2) = S1 right shift	SR (S2),S1
1 1 1 1	(S2) = S1 right rotate	RR (S2),S1

Figure 6: EGO's *indirect result instructions.*

tinues. Also, when the data instruction is ignored, the ALU is not used, so the condition flags remain set at their previous values. This makes it easy to test and execute instructions for different conditions.

The miscellaneous instruction set is a subset of the data type. The instruction code is the same as the data instructions, except that bit 9 is zero. These instructions do not fit the general pattern of the rest of the instructions. The no operation, set carry flag, clear carry flag, and halt instructions are defined in figure 3.

The register, indirect operand, and indirect result instructions require only one word. For register instructions, S1 and S2 are direct operands, and the result is stored in register S2. For indirect operand instructions, S1 operand is indirect, S2 is direct, and the result is stored in register S2. For indirect result instructions, S1 operand is direct, S2 is indirect, and the result is sent to S2 indirectly.

The 16 ALU operations are pretty standard. They include the load, increment, subtract, subtract with carry, negate and add, negate and add with carry, add, add with carry, exclusive-OR, shift left, OR, rotate left, AND, decrement, shift right, and rotate right instructions. Although they're very basic, these instructions allow you to perform a number of powerful operations, especially when they're used with the program counter.

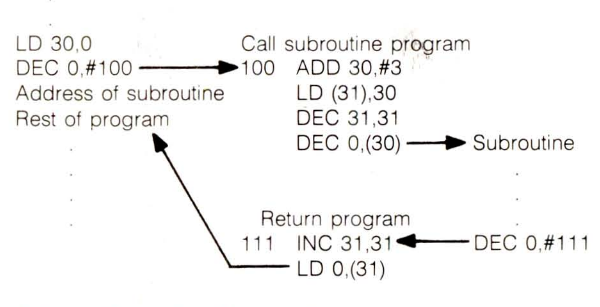
The instruction set takes some getting used to. Since I made the program counter a general-purpose register, data instructions can be used as direct or relative jumps. For example, the instruction LD0,#8 loads the program

(continued)

Listing 1: EGO *assembly-language code for direct and relative subroutine calls. Registers* 30 *and* 31 *had to be used to manage a software stack. The instruction* DEC 0,#100 *performs an unconditional jump to memory location* 100.

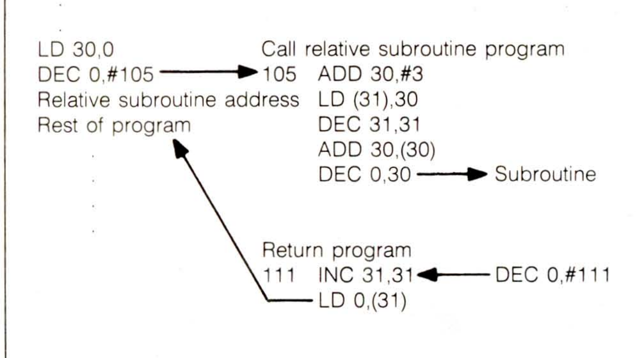
Direct Address Call and Return

Program



Relative Subroutine Call and Return

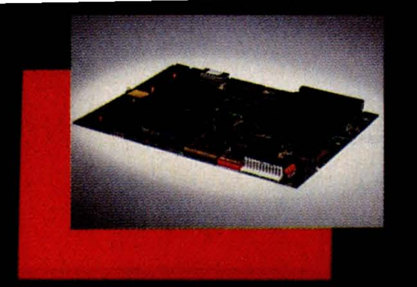
Program



counter with the value 8, which is actually an unconditional jump to memory location 9 (since the program counter is automatically incremented at the end of every instruction). I can use any register as an index register. The simplicity gained by my instruction set resulted in a few strange-looking instructions. I have not yet found a use for some of the data instructions.

Since all of EGO's registers are general-purpose, it becomes the programmer's job to dedicate and keep track of any registers that may be needed for special purposes. Up to this point, I've dedicated only registers 30 and 31 for handling a stack. One of the most important groups of instructions a computer can provide is routine call and return instructions. EGO's flexible structure allows this, although it requires some extra code that most micropro-

(continued)







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Listing 2: EGO *assembly-language code for the interface program.*

Memory Location	Instruction	Comments
0	LD 3,#8188	Load interface address into R3
2	LD 2,(3)	Load instruction into R2
3	AND 2,#255	Use only lower order byte of R2
5	SL 2,2	Multiply R2 by 2
6	SL 1,2	Multiply R2 by 4
7	ADD 1,2	Add for multiply by 6
8	ADD 0,1	Add to PC for mem location
9	NOP	INST #0 NOP loop
10	NOP	
11	NOP	
12	NOP	
13	LD 0,#8	Go to start of NOP loop
15	LD 3,#8189	INST #1 Load address into R3
17	LD 4,(3)	Load data into R4 (address data)
18	LD 0,#8	Go to NOP loop
20	NOP	
21	LD 3,#8189	INST #2 Load address into R3
23	LD 3,(3)	Load data into R3
24	LD (4),3	Load data into (R4)
25	LD 0,#8	Go to NOP loop
27	LD 3,#8189	INST #3 Load address into R3
29	DEC 0,(3)	Go to (data)
30	LD 0,#8	Go to NOP loop
32	NOP	
33	LD 3,#8188	INST #4 Load address into R3
35	LD 2,(4)	Load (R4) into R2
36	LD (3),2	Load R2 into interface
37	LD 0,#8	Go to NOP loop

Memory location 8188 holds a number between 0 and 4. This number vectors execution to routines at locations 9, 15, 21, 27, or 33. The routine at location 9 executes NOP instructions. The routine at location 15 loads register 4 with the contents of register memory location 8189. The routine at location 21 stores the contents of memory location 8189 at the address pointed to by register 4. Location 27's routine transfers control to the program whose start address is stored in memory location 8189. Finally, location 33's routine moves the data at the memory location pointed to by register 4 into location 8188. By storing the proper information at locations 8188 and 8189, another processor connected to EGO's data bus can effectively move programs into EGO for execution and retrieve the results.

cessors execute implicitly. Listing 1 shows the direct and indirect subroutine calls and the return routine.

Programs and Benchmarks

Listings 2 and 3 are examples written in assembly language for EGO. Listing 2 is the source code for the interface program. It resides at the lowest part in memory so that on an interrupt, this program controls what occurs. The interface program allows a simple means of communicating with EGO using memory-mapped I/O (input/output). It recognizes five instructions: no operation, load address data, send data to memory defined by the address data, go to the address data location and run a program, and send data from the address location to the interface program.

Listing 3 is a simple 8- by 8-bit multiply program controlled by the interface program.

Listing 3: EGO *assembly-language code for an 8- by 8-bit multiply.*

Memory Location	Instruction	Comments
2048	LD 5,4	Load first number into R5
2049	LD 0,#8	Return to no-op loop in interface program
2051	LD 6,#8	Load number of bits into R6
2053	LD 8,#0	Clear result register R8
2055 loop	RR 5,5	Rotate rightmost bit into carry flag
2056	ADD 0,#1 I	Jump to shift on no carry
2058	ADD 8,4	Add R4 to R8 to generate the result
2059 shift	SL 4,4	Shift R4 one bit left
2060	DEC 6,6	Decrement the bit count
2061	SUB 0,#8 P	If R6 is positive make another loop
2063	LD 3,#8188	Load address of interface into R3
2065	LD (3),8	Send result to interface
2066	LD 0,#8	Return to no-op loop in interface program

To get an idea of EGO's speed, I wrote a machine-language version of the Sieve of Eratosthenes program. Although EGO doesn't have enough memory to run the entire 16K-byte limit for primes, I ran it to 2K and extrapolated. Based on those calculations, it would take EGO about 3.6 seconds to do 10 iterations up to 16384. This is approximately one-half the time required for a Z80 to make the same calculation running at the same clock speed. With the 4-MHz clock and the average instruction taking between 6 and 9 clock periods, EGO can average about 0.5 million instructions per second.

Since I am interested in simulation and one of the purposes of EGO was to be useful, I wrote some integer and floating-point routines to start an operating system. The floating-point variables have a 32-bit signed mantissa and a 16-bit signed exponent. This provides about nine decimal places, or accuracy with an exponent greater than 9000. Benchmarks on these routines provided these results:

Multiply	0.575 ms
Divide	0.955 ms
Add	0.115 ms

It is interesting to note that while the hardware for EGO took only a few months to complete, the software has taken much longer. Presently, on the Tandy 2000 I have an assembler, an editor, a tiny FORTRAN-type language compiler, and a linker written in BASIC.

Next month I'll discuss the design details of EGO's hardware. We'll take a tour of a machine cycle and see how the hardware supports the EGO instruction set. ■

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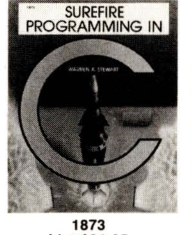
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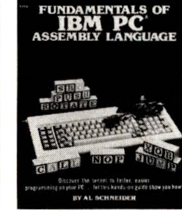
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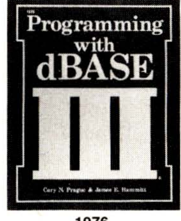




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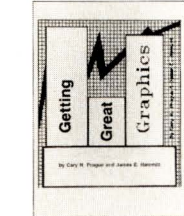
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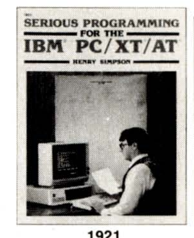
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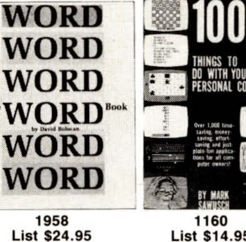
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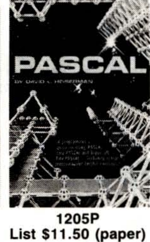


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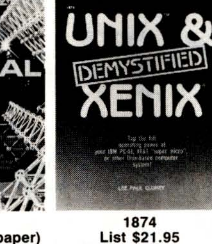


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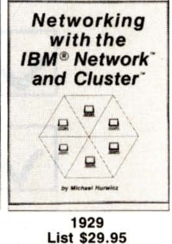
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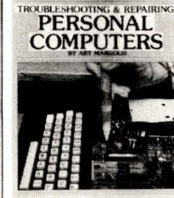
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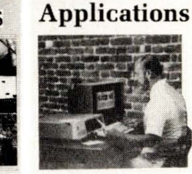
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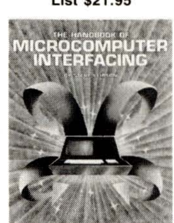
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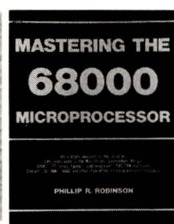
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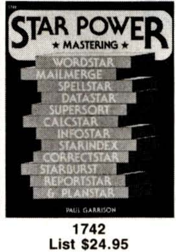
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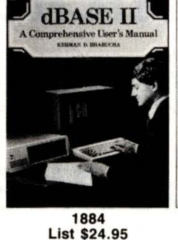
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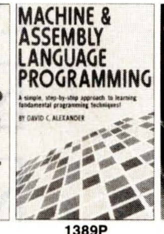
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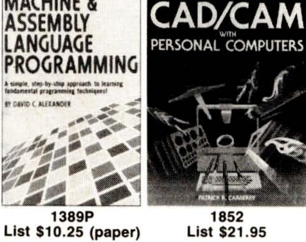
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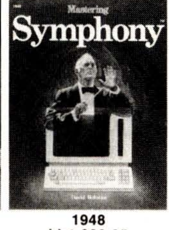
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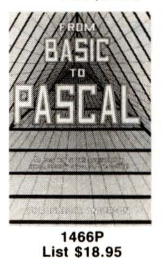
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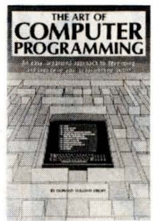
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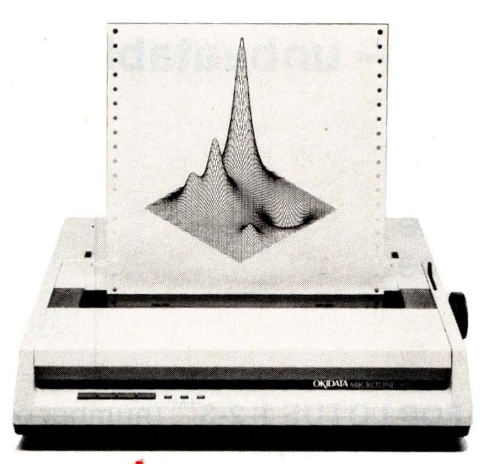
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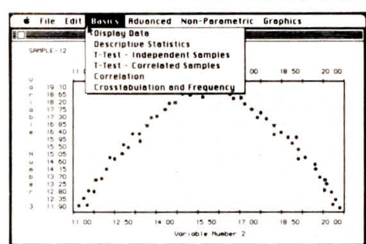
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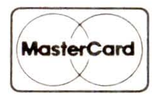
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THE QUARTER-MEG ATARI 800XL

BY CLAUS BUCHHOLZ

Upgrade your 8-bit microprocessor to 256K bytes and add a RAM disk

IT'S GETTING HARDER to find a microcomputer with less than 64K bytes of RAM (random-access read/write memory). A couple of years ago, the cost per bit of the 64K-bit RAM fell below its predecessor, the 16K-bit dynamic RAM, and the 64K-byte address space supplied by eight of the 64K-bit chips is ideal for the most common 8-bit microprocessors. Now, however, the cost per bit of the 256K-bit dynamic RAM is the lowest, and it is already common in powerful 16- and 32-bit microcomputer systems.

Since eight of these chips provide one-quarter of a megabyte and since they are so similar to their ancestors, it is tempting to upgrade an inexpensive 64K-byte micro to 256K bytes. Obviously, you can't fit 256K bytes of memory into the 64K-byte address space of a 6502 or Z80 all at once, but you can break it up into manageable chunks, called banks, and allow the processor to see one bank at a time. This method of interfacing RAM, called bank selection, requires some new hardware and software support.

This article describes the upgrade and presents a RAM-disk controller for the Atari 800XL. However, you can apply the basic idea to any micro that uses 64K-bit RAMs—the Apple IIe, the Commodore 64, the MSX machines, and others.

THE ATARI 800XL

The 800XL is a modern version of the popular Atari 800. [*Editor's note: See Jon Edwards's "Atari 800XL" system review, March* BYTE, *page* 267.] Introduced in 1979, the 800 was the first machine to use VLSI (very-large-scale integration) technology to bring advanced graphics and sound capabilities into the low-price market. It was also the first to include a full operating system in ROM (read-only memory) to support the versatile hardware. RAM consisted of up to three 16K-byte modules, each constructed around eight 16K-bit dynamic RAM chips.

In the 800, the 6502 processor shares the system with a programmable video DMA (direct memory access) controller, which halts the 6502 for one cycle of the 1.8-MHz clock when it needs to access a byte of screen memory. The 800XL incorporates the same VLSI hardware with newer, higher-density RAM and ROM. One 16K-byte ROM holds the entire operating system, and another 8K-byte ROM contains the BASIC language. The RAM consists of eight 64K-bit dynamic RAM chips. Under BASIC, 40K bytes of RAM are usable. The ROMs, which occupy high memory space, can be disabled to gain access to the remaining RAM. The new design is smaller, cheaper, less power-hungry, and more attractive. The Atari is unquestionably a very fine machine.

THE DYNAMIC RAM

The industry-standard dynamic RAM chip is itself an example of superb design. It is small, dense, adequately fast, and cheap. In the last decade, its memory capacity has doubled eight times without the chip outgrowing its 16-pin IC (integrated circuit) package. Each chip inputs or outputs one bit at a time, so each bit has a unique address.

For the 256K-bit chip, the address requires 18 bits. The chip has nine address inputs, each of which does

(continued)

Claus Buchholz (201C East Edgewood, Lansing, MI 48910) is a programmer for Meridian Instruments. He has a B.S. in astrophysics and computer science from Michigan State University. He uses an Atari 800 with a homebrew 192K-byte RAM and an ATR-8000.

double duty. During the first part of a memory access, half of the address bits are presented to the chip. This half is called the *row address*. Later in the access cycle, the chip receives the other half of the address, called the *column address*. The storage cells in the chip lie in a matrix, and the cell being addressed lies at the intersection of the row and column specified. To complete the access cycle, the chip reads or writes the selected bit.

The 800XL uses 64K-bit RAM chips, which have eight address inputs for an 8-bit row address and an 8-bit column address. This is fine for the 16-bit addresses the 6502 supplies. There are eight chips, and each contributes one bit to each byte of RAM.

The 256K-bit RAM is practically identical to the 64K-bit RAM except that it has one extra pin, #1 on the chip, to accommodate the two additional address bits it needs. Pin #1 on the 64K-bit chip has no function. The functions of all the other pins on both chips are identical. Therefore, our upgrade involves unplugging the eight 64K-bit RAMs and placing eight 256K-bit chips in their place. We must also add some circuitry to provide two extra address bits for pin #1.

The storage cells in dynamic RAM chips are actually microscopic capacitors, storing an amount of electric charge that represents a 0 or 1 bit. Since capacitors leak charge, they must be periodically recharged or refreshed. The chip refreshes one or two entire rows when accessed. Every row must be accessed frequently to keep the stored data accurate, but normal operation of RAM can't guarantee that. The computer system must therefore provide special access cycles called *refresh cycles*, dummy read cycles in which refresh addresses are used as row addresses.

The 16K- and 64K-bit RAMs require 7-bit refresh addresses. The computer must provide all 128 possible refresh addresses every few thousandths of a second to keep the RAM refreshed. In the Atari, the video controller, which provides refresh cycles in addition to its screen-memory accesses, automatically provides 7 bits for the refresh address. The Atari, in fact, spends 8 percent of its time refreshing RAM.

One snag in designing the 256K-byte upgrade is that standard 256K-bit RAMs require an 8-bit refresh address. Older versions of the Atari video-controller chip provide only 7 bits of refresh address; newer versions provide all 8 bits. Therefore, I have designed two versions of the upgrade's interface circuit. The more complex one must add another bit to the Atari's refresh address. (See table 1 for a list of components.)

BANK SELECTION

To fit 256K bytes into the 6502's 64K-byte memory space, you must divide it into banks. The upgrade uses eight 32K-byte banks, numbered 0 through 7 and selected by setting 3 bits in the Atari's memory-control register. Any one bank can appear in the lower half of the 6502's memory space. At power-up, bank #7 appears in the lower 32K bytes of RAM, bank #6 appears in the top 32K bytes, and the Atari acts as a normal 64K-byte machine. To access bytes in the other 192K, a program must select one of banks #0 through #5, which would then appear in place of bank #7. After accessing the bytes, the program could then switch bank #7 back in, restoring the normal configuration.

I used eight 32K-byte banks instead of four 64K-byte banks for three reasons. If a program in RAM were to replace the entire 64K bytes of RAM with another bank, it would cause itself to disappear, crashing the system. Moreover, the top 32K bytes of the address space is already cluttered with hardware addresses and ROMs that can be switched in and out. Finally, the screen RAM is usually in the top 32K; switching it out would cause glitches to appear on the screen.

Even with eight 32K-byte banks, we must be cautious. The operating system keeps important data in the lower part of RAM, and it expects the data to be there. Worse, interrupts frequently invoke routines that keep data in low RAM. Programs must therefore follow a strict rule: Keep bank #7 enabled as much as possible. If you select another bank, you must first disable all interrupts and not call the operating system until bank #7 is restored. One further consideration involves the 6502's stack, which is in low memory. The program should not use the stack when bank #7 is not selected, unless it takes great care to keep the stack valid.

INTERFACING THE RAM

Figure 1 is a schematic diagram of the interface circuit for the 256K-byte RAM. It must be assembled on a small circuit board and installed inside the computer because the computer's expansion slot doesn't carry the signals we need. The circuit consists of two chips and replaces one of the chips on the motherboard. It also requires four jumper wires to various points on the motherboard.

The circuit plugs into the socket at position U27 on the motherboard. This gives it access to six important

(continued)

Table 1: *The components you'll need to upgrade the* Atari 800XL.

Quantity	Part Number	Description
8	41256	256K-bit dynamic RAM (200 ns or faster)
1	—	33-ohm, ¼-watt resistor
(following part for circuit in figure 1 only)		
1	74LS153	Dual 4-to-1 multiplexer
(following parts for circuit in figure 2 only)		
1	74LS151	8-to-1 multiplexer
1	74LS393	Dual 4-bit counter
1	74LS00	Quad NAND gate

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signals, including power and ground. The chip that was at U27 becomes IC1 in the circuit. As U27, this chip was one of the two responsible for selecting which 8 of the 16 address bits were passed to the 64K-bit RAMs at one time.

IC2 performs the bank selection by modifying one of the eight original address inputs to the RAMs and adding a ninth. The bank-selection circuitry needs three jumpers from the motherboard to carry 3 bits from the Atari's memory-control register. A fourth jumper carries the ninth address input to the RAMs.

Figure 2 shows the four-chip interface circuit necessary for machines containing the older version of the video controller. IC3, an 8-bit binary counter that counts the refresh cycles, supplies the eighth bit of the refresh address for the 256K-bit chips. The refresh signal it uses comes through a jumper wire from the motherboard. Parts of IC1, IC2, and IC4 perform the bank selection in this circuit.

PERFORMING THE UPGRADE

To disassemble the 800XL, remove the six screws on the underside and separate the top and bottom portions of the plastic case. Be careful of the flexible keyboard cable. Pull it straight up out of its socket on the motherboard. To detach the motherboard from the case bottom, remove three screws—one on the right side, one in the right rear corner, and one in the left rear. Gently pull the board free.

Next, remove the small nuts and bolts around the metal shielding that encases the motherboard. On the left side of the exposed motherboard, locate the row of eight 16-pin RAM chips. Just to their right is U27. Behind

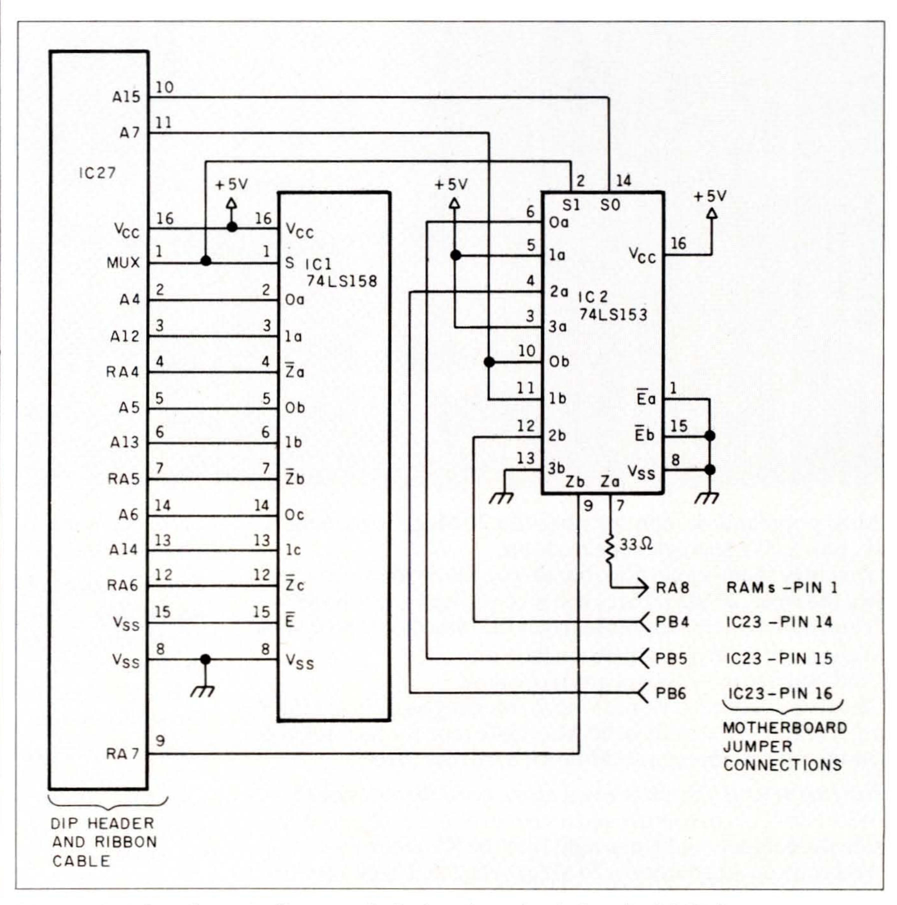


Figure 1: *The schematic diagram of the interface circuit for the 256K-byte RAM. Use this circuit if the part number on the video controller is CO21697.*

U27 is a 3-inch square area that fits inside the shielding. The circuit goes there because the shielding is highest toward the rear.

Replace the 64K-bit RAMs with the 256K-bit RAM chips. The new RAMs are very easily destroyed by static discharges, so extreme care is necessary in their handling. Lay aluminum foil on the work surface and keep the motherboard, RAM chips, tools, and your hands in contact with the foil at all times. This keeps everything at the same potential, decreasing the possibility of damage.

On the motherboard, locate the video controller, the 40-pin chip at U7. If the part number stamped on it reads "CO21697," you can use the simpler circuit shown in figure 1. If the number reads "CO12296," you must use the larger circuit.

Assemble the appropriate circuit on a 2- by 3-inch circuit board (Radio Shack's #276-150 is ideal). Use very low-profile sockets or no sockets at all because the shielding severely limits the height. If you do not use sockets, be careful not to apply heat to the IC pins for too long. Keep the wiring on the chip side of the board to conserve space. The wiring must be soldered because there is no room for wire-wrap posts.

The board plugs into the socket at U27 via a 16-pin DIP header and short ribbon cable. Finally, install the jumper wires. Find a resistor marked R32 immediately behind the row of RAM chips and remove it. A trace from one of the holes runs to pin 1 of the RAMs. Solder the first jumper to that hole. The next three jumpers run to a parallel port that the Atari uses to control ROM switching. We need pins 14 through 16, which are normally unused and not connected to any traces. Locate U23 and carefully pry the 40-pin chip from its socket. Bend up pins 14, 15, and 16 so that they point straight out. Reinsert the chip. Cut three adjacent pin positions from an IC socket and solder the three jumpers to them. Use this custom socket to connect the jumpers to the three protruding pins.

(continued)

Cover the connector with electrical tape because the shielding is very low at this point.

If you are using the circuit of figure 2, you must install a fifth jumper. Locate a trace on the motherboard from pin 8 of the video controller, U7. Find a hole along the trace and solder the jumper there. Finally, insert a thin piece of stiff cardboard or plastic under the small circuit board to avoid shorting the circuit. Refasten the shielding to the motherboard. If it doesn't fit over the circuit, carefully pound a dent out of the shielding with a hammer. Reassemble the computer. If all has gone well, the computer should power up normally and perform exactly as before, as long as the 3 bits in the memory-control register are left alone. The computer is ready to try some software that makes use of the large RAM space.

THE RAM-DISK SOFTWARE

Bank-selectable RAM is useless without software to control it. The software must obey strict rules as outlined above to work properly. The software must also be tailored to fit the application.

For example, you could store many graphics screens in the RAM and use page flipping to display them in quick succession for animation. Alternatively, the RAM could act as a print spooler. A word processor could print an entire document quickly into the RAM and go on to other jobs while the RAM emptied its contents slowly to a printer.

A more universal application is the RAM disk, a RAM-based disk-drive simulator. To DOS (disk operating system) and to the user's programs, the RAM disk appears to be just another disk drive, except that it is very fast. Application programs could then use standard DOS commands to access the large RAM space. The 192K bytes of available RAM hold more data than two Atari 810 drives or one double-density drive. I have written an assembly-language program that modifies the Atari's operating system to treat the RAM as either a single-density or double-density disk drive. The program is available for downloading as ATARIRAM.ASM on BYTEnet Listings, (617) 861-9774. It works with Atari DOS 2.0, OS/A+ (versions through 2.xx) and compatible DOSes. Assemble the source code with any assembler that accepts the syntax of the Atari Assembler/Editor. Assembly produces an object file that performs several tasks as it loads. First, it copies the operating system from ROM into the underlying RAM. Next, the RAM-disk routines load into the RAM-based operating system, overwriting the international character set, a little-used feature of the 800XL. Finally, it

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patches the operating system to install the RAM-disk program and calls DOS's initialization routine to let DOS recognize the new drive.

The source code provides two options: the drive number and the density. The RAM disk can act as any drive numbered 1 to 8. If you have one real drive, you might want the RAM disk to be drive number 2.

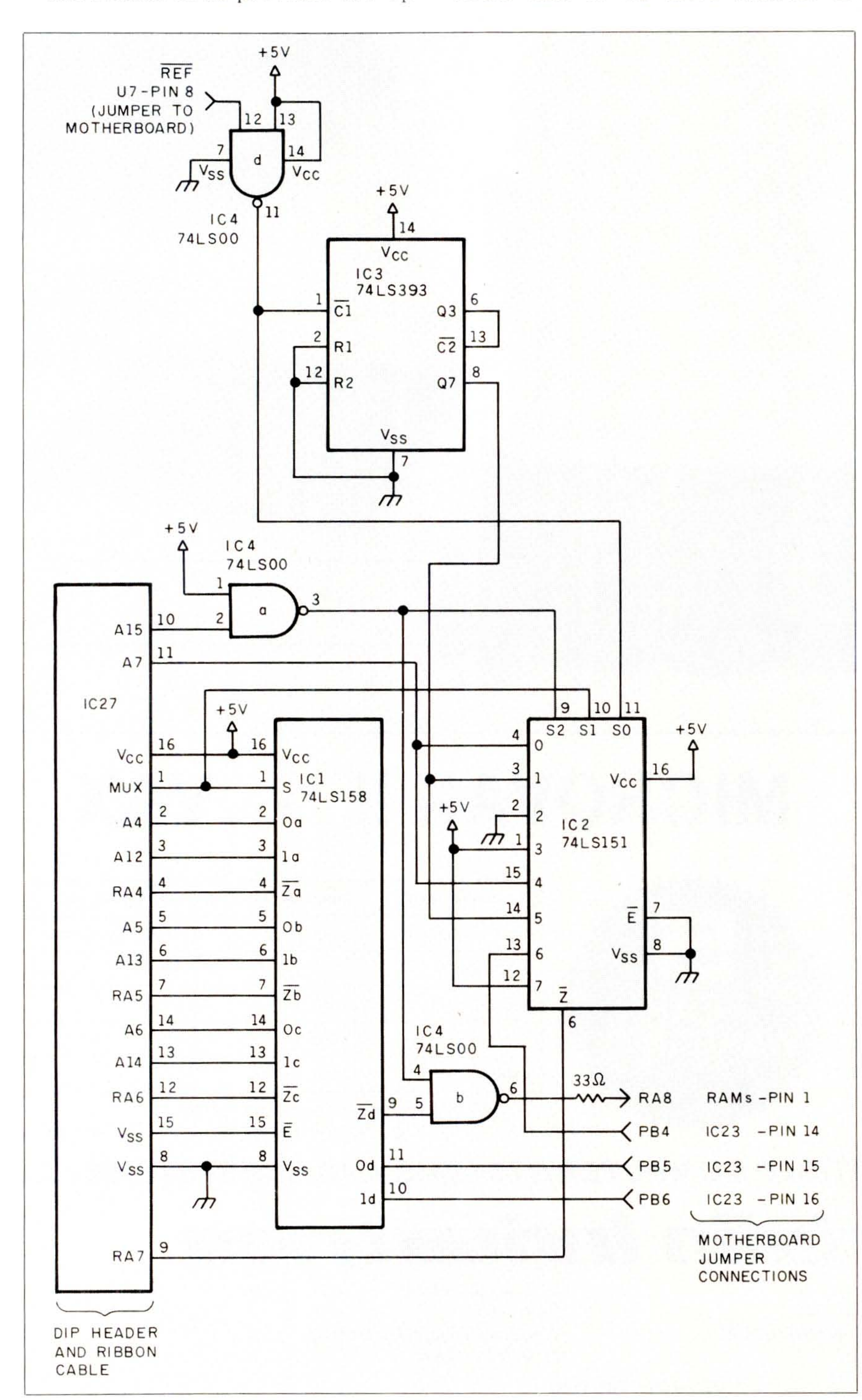


Figure 2: *Use this circuit if the video controller part number reads* CO12296.

Remember that your DOS must be set up to look for the drive number chosen. See the DOS manual for instructions concerning drive numbers.

Like the Atari 810 disk drive, a single-density RAM disk has 720 sectors of 128 bytes each, for a total of 90K bytes. Like all double-density disk drives for the Atari, a double-density RAM disk has 720 sectors of 256 bytes, for a total capacity of 180K bytes. Atari DOS checks each drive in a system for its density and compensates. All DOS functions except duplicate disk operate with double-density drives. You obviously cannot duplicate a double-density disk to a single-density disk and vice versa.

Boot in the RAM-disk object file after DOS by renaming the object file AUTORUN.SYS. Once the file has loaded, you must format the RAM disk before use. You can do this manually from DOS, use the BASIC XIO command, use a call to CIO in machine code, or rely on an application program.

RESET and warm starts won't harm the contents of the RAM disk. If you reboot without powering down (through a POKE 580,1 and RESET, or by jumping to $E477 in machine code), you must reload the RAM-disk program to access the data, which will remain unharmed in the RAM disk. The RAM-disk program, therefore, does not automatically format the RAM disk upon loading.

The major disadvantage of the RAM-disk approach is that all data is lost when the computer is turned off. You should therefore be sure to save important data to a real disk before ending. However, the speed, convenience, and versatility of the RAM disk outweigh its drawbacks.

USES

Assembly-language programmers, after studying the RAM-disk source code and heeding the rules above, can devise many practical uses for a quarter-megabyte of RAM. The large RAM space, joined with the Atari's versatile hardware and low price, provides a performance/price ratio that is unbeatable in today's market. ■

A PARALLEL-TO-SERIAL PRINTER PORT ADAPTER

BY HOWARD AUSTERLITZ

Build this $35 adapter and use your parallel port for serial devices

MOST PERSONAL COMPUTERS have at least one parallel (Centronics) printer port. But if your printer has a serial (RS-232C) interface, that parallel port is usually wasted. The adapter described here can be built for around $35 and will convert the output of your computer's parallel port to serial form for driving a printer, plotter, or any read-only device.

The only limitation of this device is that it must use hardware as opposed to software (XON/XOFF) handshaking. However, software handshaking detection can be added. While the circuit shown in figure 1 was designed to work with the IBM Personal Computer and compatibles, it will also work with most other personal computers that have a Centronics-compatible printer port. Best of all, it requires no extra software. It looks just like a parallel printer to your computer.

CIRCUIT OPERATION

The heart of the adapter is IC1, a UART (universal asynchronous receiver/transmitter) that converts the 8 parallel bits coming from the PC to a serial bit stream driving the printer. The serial data rate out of the UART is determined by IC2, the clock generator, which is a 555 oscillator set at 16 times the desired data-transmission rate. Transmitter IC4 converts the UART's TTL (transistor-transistor logic) output to RS-232C levels.

Two control lines from the PC's parallel port are used—$\overline{\text{STROBE}}$ (output) and BUSY (input). At power-on, IC1 and IC5 are reset by R4, C3, and IC3c, initializing the BUSY line to low. After the PC has put valid data on the parallel port (output lines D0–D7), it sends a (low) pulse to $\overline{\text{STROBE}}$. This pulse loads the parallel data into IC1 and begins the serial data transmission by activating its DS (data strobe) line. It also sets the flip-flop IC5, keeping the PC's BUSY line active (high). The PC will not send another character until its BUSY line goes low again. When IC1 has finished the serial transmission, its EOC (end of character) line outputs a high pulse that resets IC5 and returns the PC's BUSY line low. Now another $\overline{\text{STROBE}}$ pulse from the PC can begin the next character-transmission cycle. Switch S1 allows a manual reset at any time to turn off BUSY.

Some serial printers have a hardware handshaking (output) line on their RS-232C interface to tell the computer if it is ready, busy, or has an error condition. This line, designated READY/$\overline{\text{ERROR}}$, is converted to TTL levels by the RS-232C receiver, IC6, and then applied as one input to OR gate IC7b along with the output of IC5 to drive the PC's BUSY input. This enables the printer to suspend the PC's output when needed. If your printer or plotter doesn't have a READY/$\overline{\text{ERROR}}$ line, you can leave out IC6 and IC7b (connect IC5 pin 5 directly to CONN1 pin 11).

The adapter requires three power-supply voltages: +5 volts at 150 milliamps for most of the chips, and ±5 V to ±15 V at 20 mA for the RS-232C

(continued)

Howard Austerlitz is an instructor in the Department of Materials Science and Engineering at State University of New York at Stony Brook (Stony Brook, NY 11794) and a researcher interested in ultrasonics, signal analysis, and multiprocessor computer systems.

To set the data rate, connect a frequency counter or oscilloscope to the output of IC2 and adjust the trimmer potentiometer to obtain 16 times the desired data rate.

transmitter, IC4. You can either use commercial power supplies or build the one shown in figure 2. This unit uses an inexpensive, unregulated wall transformer power supply, nominally +9 V at 250 mA, which is filtered for IC4's +9 V source and regulated by IC8 for the +5 V source. This +9 V also powers IC9, a negative voltage converter, which produces the (nominal) −9 V for IC4. R6 and Zener diode D1 protect the input to IC9, which is rated at 10 V maximum.

CONSTRUCTION

Figure 3 lists the parts necessary to build this parallel-to-serial adapter, and photo 1 shows a top view of the assembled adapter board. The construction method you use can be wire-wrap and/or point-to-point soldering. Use sockets for all ICs (except IC8, the +5 V regulator). You can wire the parallel-port connector (CONN1) to a DIP header via ribbon cable, but try to keep this cable as short as possible.

SETUP

After wiring the adapter, test the power supply before you plug in any ICs. If +9 V is not present, neither will +5 V or −9 V be (if you use the supply from figure 2). LED1 ("Power") should light. Check for proper supply voltages at the IC sockets. Now turn off the power and plug in the ICs, but do not connect the PC or printer yet.

(continued)

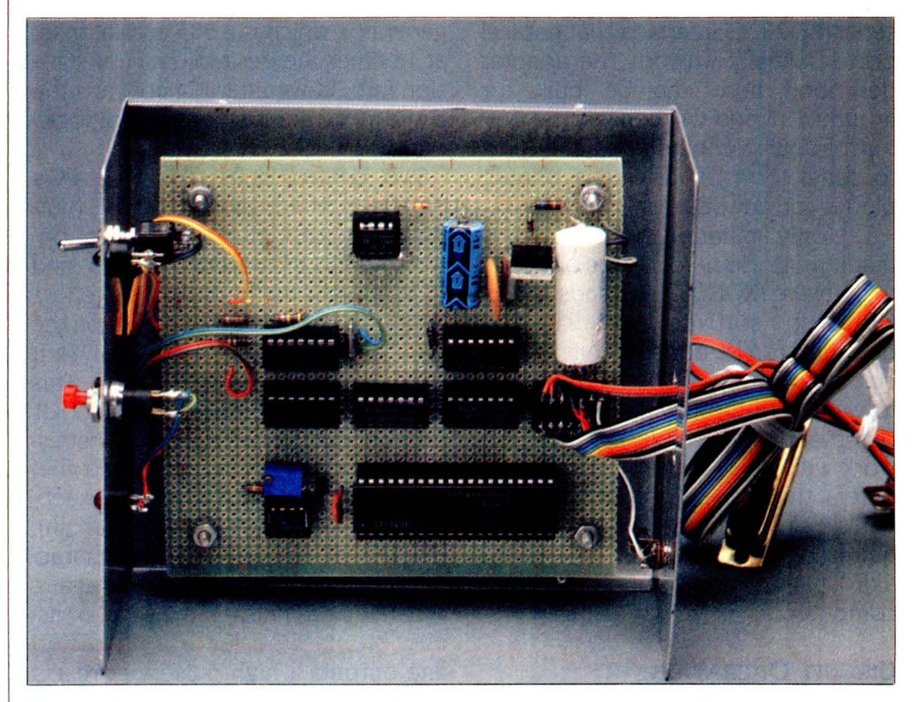


Photo 1: *A top view of the parallel-to-serial printer port adapter. Notice the power toggle switch, reset button, and BUSY LED indicator on the left side of the case and the parallel cable and serial cable extending out the right.*

Figure 1: *A schematic for the parallel-to-serial adapter. The UART (IC1) converts the 8 bits coming in at the parallel port (CONN1) to a serial bit stream output at serial port CONN2 that can drive a read-only device with an RS-232C interface.*

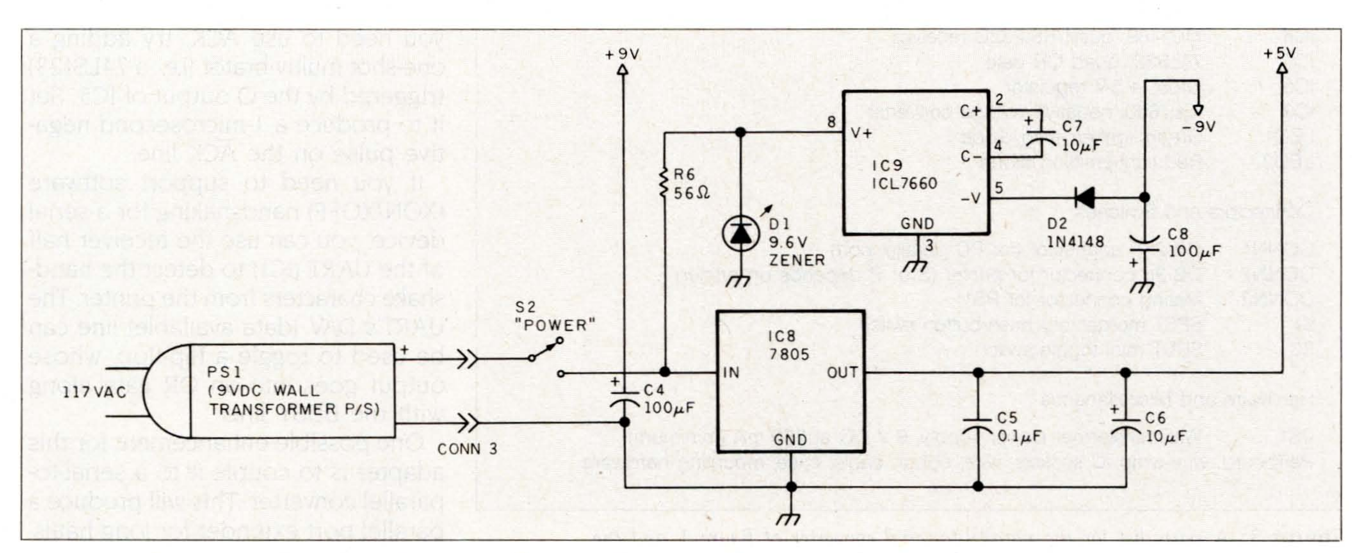


Figure 2: *The power-supply adapter for the parallel-to-serial converter of figure 1.*

First, the data rate has to be set. Connect a frequency counter or oscilloscope to the output of IC2 (pin 3). Adjust trimmer potentiometer R3 ("Baud Adj.") to obtain 16 times the desired data rate. For example, if you need 300 bits per second for your serial printer, adjust R3 for 4800 Hz (300×16). If you're running faster than about 2400 bps, you'll have to decrease the value of C2 to get the required frequency.

Next, wire in the RS-232C connector (CONN2). Check the user's manual on your printer for information on wiring its serial interface. You may have to jumper DTR (data terminal ready) to DSR (data set ready) on the printer's connector to enable it.

Finally, wire in the parallel port connector. The pin numbers given in figure 1 are strictly for an IBM PC that uses a DB-25 connector instead of the standard Centronics one. Note that

One possible enhancement for this adapter is to couple it to a serial-to-parallel converter.

+PEND (pin 12) is grounded to ensure that the PC doesn't think the printer is out of paper.

Normally, when the adapter is first turned on, LED2 (BUSY) should not light if the parallel port is inactive. Regardless, pressing switch S2 (Reset) will turn it off. When the printer port is being used, LED2 will be flashing on and off. Remember that it only gives an indication that the UART (IC1) is busy, not necessarily the printer (if the READY/ERROR line is used).

OTHER NOTES

Some personal computers have parallel ports that use a second input control line (besides BUSY), the ACK line. If required, a low pulse must be present on this line before the PC will send the next character (even if BUSY has been reset). Most PCs do not use ACK since BUSY provides all the required handshaking. However, if you need to use ACK, try adding a one-shot multivibrator (i.e., a 74LS123) triggered by the Q output of IC5. Set it to produce a 1-microsecond negative pulse on the ACK line.

If you need to support software (XON/XOFF) handshaking for a serial device, you can use the receiver half of the UART (IC1) to detect the handshake characters from the printer. The UART's DAV (data available) line can be used to toggle a flip-flop, whose output goes into an OR gate along with the BUSY line.

One possible enhancement for this adapter is to couple it to a serial-to-parallel converter. This will produce a parallel port extender for long hauls. Use your imagination and see what else you can come up with. ■

PARTS LIST

Resistors (¼-W, 10 percent)

R1,R5	510 ohms
R2	2000 ohms
R3	50,000 ohms trimmer potentiometer—10 turn
R4	470,000 ohms
R6	56 ohms

Capacitors

C1	0.01 μF, 50-V disc
C2	0.001 μF, 50-V metal film
C3	1 μF, 50-V electrolytic
C4,C8	100 μF, 35-V electrolytic
C5	0.1 μF, 50-V disc
C6,C7	10 μF, 35-V electrolytic

Semiconductors

D1	9.6-V, 1-W Zener diode
D2	1N4148, general-purpose diode
IC1	AY3-1015D, UART
IC2	LM555, timer
IC3	74LS00, quad NAND gate
IC4	MC1488, quad RS-232C transmitter
IC5	74LS74, dual D flip-flop
IC6	MC1489, quad RS-232C receiver
IC7	74LS32, quad OR gate
IC8	7805, +5-V regulator
IC9	ICL7660, negative voltage converter
LED1	Green light-emitting diode
LED2	Red light-emitting diode

Connectors and Switches

CONN1	DB-25P connector (for PC parallel port)
CONN2	DB-25 connector for printer (S or P depends on printer)
CONN3	Mating connector for PS1
S1	SPST momentary push-button switch
S2	SPDT mini toggle switch

Hardware and Miscellaneous

PS1	Wall-transformer power supply, 9 V DC at 250 mA (minimum)

Perfboard, wire-wrap IC sockets, wire, ribbon cable, case, mounting hardware

Figure 3: *A parts list for the parallel-to-serial converter of figure 1 and the power-supply adapter of figure 2.*

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ADD FUNCTION KEYS TO YOUR MICROCOMPUTER

BY MARK HANSLIP

Expand your parallel keyboard

MOST MICROCOMPUTERS now coming into the market have built-in software-programmable function keys. Many applications require the use of function keys, partly because they provide a consistent and quickly mastered user interface. Undoubtedly, many owners of older machines would also like some of that simplicity. For those whose machines did not come so equipped, the answer is a function-key generator.

I have designed a function-key-generator circuit that will produce up to 15 keystrokes with the push of one button. You can attach the circuit to the parallel-encoded keyboard of any microcomputer or word processor and use it with any operating system. The design allows 40 function keys and can be expanded to 60. You can also expand the 15-keystroke limit. The entire project involves two separate devices—a keyboard splitter and a function generator—and costs approximately $20 to assemble.

KEYBOARD SPLITTER

The keyboard splitter is a very simple device (see figure 1). Its function is analogous to a coaxial antenna splitter; it combines two signals in one. When the keyboard splitter is connected, it allows the keyboard and the function-key generator to work without interfering with each other.

When both strobes are high, both 74LS244 buffers go into a high Z state. When either strobe is low, the data is passed through that specific buffer. The other buffer will still be in a high Z state and will not impair valid data. The pull-up resistor on the FKSTB (function-key strobe) line allows you to disconnect the function generator, so it will not trigger falsely. In an idle state, the strobes from your keyboard (STB) and FKSTB are both high, generating a low output at pin 6 of the 7400 NAND gate. When either strobe goes low, the output at pin 6 will go high until both strobes go high again. I have included another 7400 gate to provide an inverted strobe output (at CSTB) for those computers that require it. The function-key generator produces a high-going-low strobe. Some keyboards are low-going-high and some are the opposite. Determine which type you have before you start. Check your computer's schematic or use a logic probe. For a high-going-low strobe from your keyboard, connect B to C and use output E to connect to your computer. For a low-going-high strobe, connect A to C and use output D.

The easiest method of construction is to use a small perf board. It should be large enough to hold all the sockets and the connector for the keyboard and the function generator. If your microcomputer has a keyboard connector (as the Apple does), it is best to use this connector so that the keyboard splitter can be removed later. Wire lengths are not critical, but it is best to keep them as short as possible.

FUNCTION-KEY GENERATOR

The function-key generator's circuitry requires a minimum of discrete com-

(continued)

Mark Hanslip is a systems analyst with NCR *in Dayton, Ohio. He is a graduate of the University of Cincinnati and a past president of the Dayton Microcomputer Association. He can be contacted at* 143 *Schloss Lane, Dayton,* OH 45418-2931.

ponents and is easy to assemble. At its heart is the 74C923 20-key encoder chip. When you connect this chip to a 4- by 5-key matrix, it provides switch debouncing, a latched output, and a DAV (data available) signal—all on a 20-pin dual in-line package.

In figure 2, the data lines of the 74C923 and S1 connect to the upper address lines of the 2716. When a key is pressed, the output of the 74C923 selects a 16-byte block in the 2716 that holds the ASCII (American Standard Code for Information Interchange) codes corresponding to one function key. The DAV line from the 74C923 goes high as long as a key is held down, resetting the outputs of the 74193 counter to zeros and holding A10 of the 2716 high. When the key is released, A10 goes low and the 0 byte of the group appears on

Table 1: *Connections for the keyboard to the 74C923.*

CODE (HEX)	ROW PIN	COLUMN PIN
0	1	12
1	1	11
2	1	9
3	1	8
4	2	12
5	2	11
6	2	9
7	2	8
8	3	12
9	3	11
A	3	9
B	3	8
C	4	12
D	4	11
E	4	9
F	4	8
10	5	12
11	5	11
12	5	9
13	5	8

the D0–D7 data lines. D7 is low on all valid data, therefore, enabling the clock output from the 74121 to go to the 74193. As the counter advances, each byte of the sequence is presented on the data lines until a byte with its high bit set to 1 is output. The high on the D7 will turn off the flow of the pulses to the 74193 and terminate the current function key's sequence. This condition lasts until a new key is pressed.

Construction of the function-key generator is easy. Most of the connections are point to point. I found it best to use project boards that have power buses running through the board (Radio Shack Part No. 276-154). This makes all the power connections much easier. A good source for keyboards is Jameco Electronics. The keyboard can be any type. The best ones are low-profile calculator

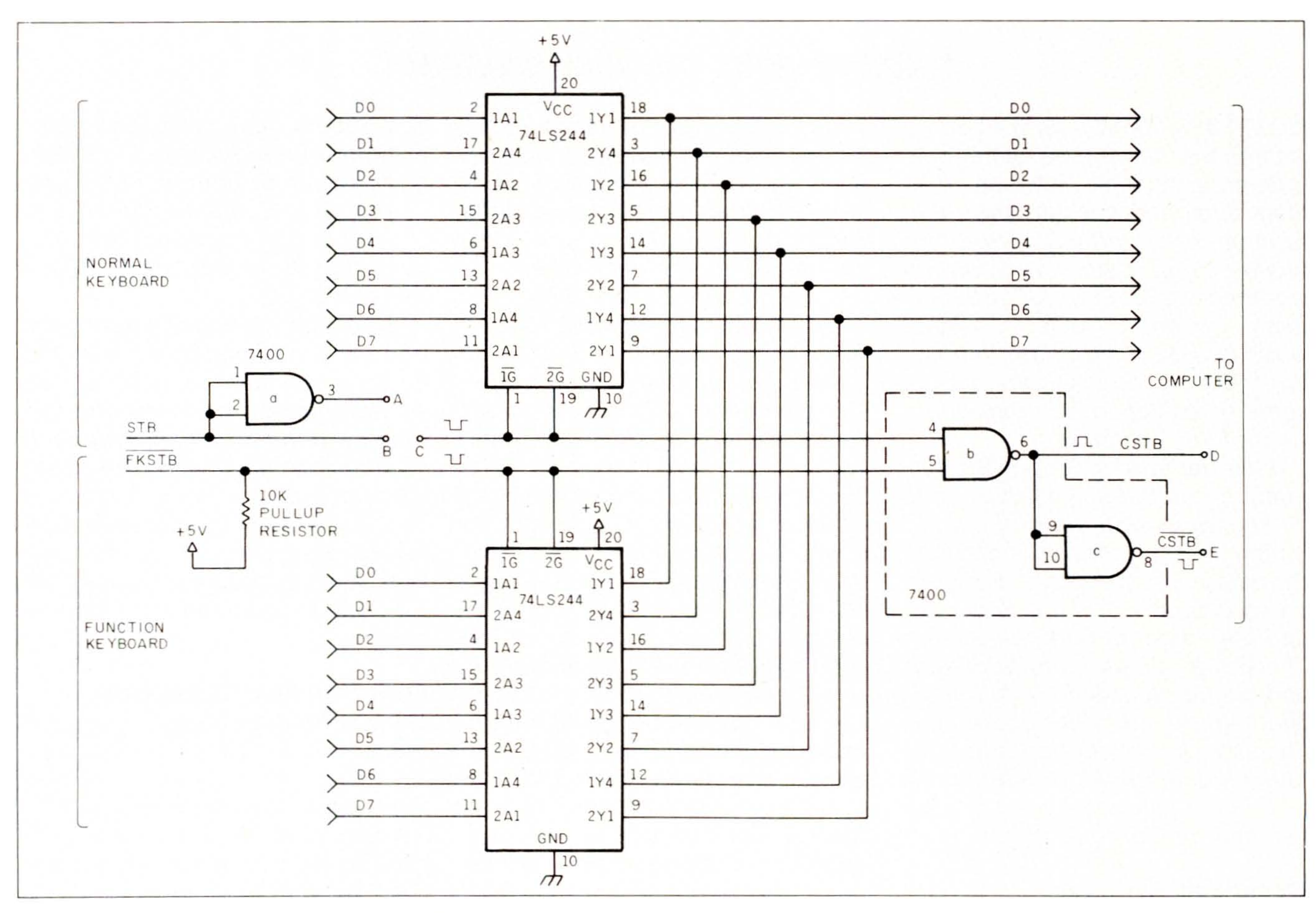


Figure 1: *A schematic for the keyboard-splitter circuit.*

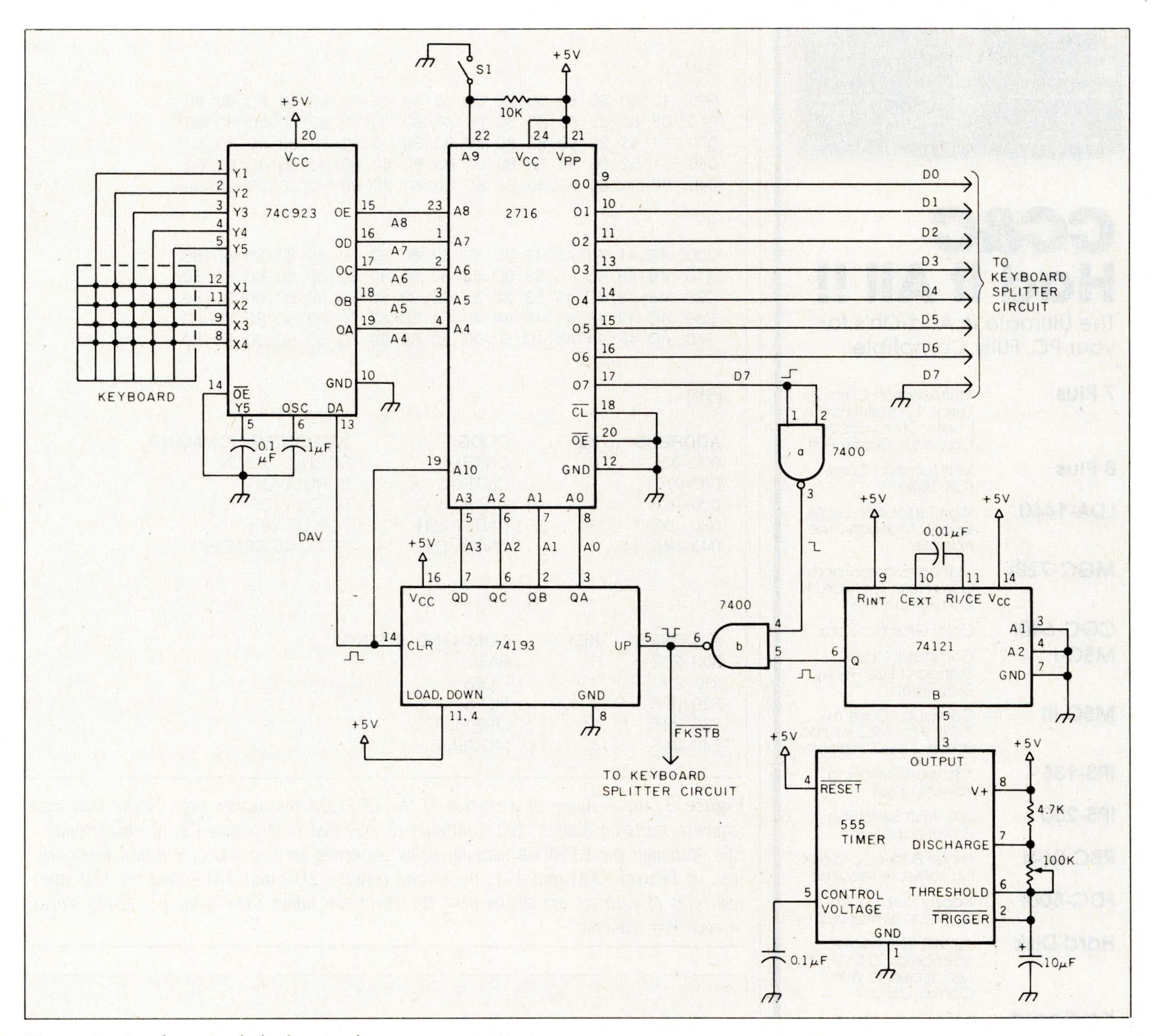


Figure 2: A *schematic of the function-key-generator circuit.*

keyboards. The keyboard should be wired in a 5-row by 4-column manner. Connect the keyboard to the 74C923 as listed in table 1.

Test the function-key generator very carefully. Turn the speed of the 555 down to very slow by adjusting the 100k-ohm variable resistor. Using a logic probe, make sure that pin 13 of the 74C923 goes from low to high when a key is pressed and returns to low when the key is released. Then check to see that pin 3 of the 74193 is changing state right after the key is released but eventually stops. Finally, verify that pin 17 of the 2716 goes high when the key is pressed and held, goes low for several counts when released, and then goes high and remains high. If your circuit fails to pass any of these tests, check for shorts, bad connections, and bad ICs.

PROGRAMMING

When you program the codes in the EPROM, all you must remember are a few simple guidelines. The function-key generator will not generate codes above decimal 127. This is not a problem for ASCII-encoded keyboards, but it can be for keyboards with special encoding. The function-key generator will produce as many as 15 keystrokes for any given key press. This includes spaces, punctuation, control codes, and carriage returns. Each set of codes must conclude with a hexadecimal 80 to shut off the counter.

(continued)

(3a)

```
000: 12 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80
010: 03 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80
020: 11 43 80 80 80 80 80 80 80 80 80 80 80 80 80 80
030: 11 52 80 80 80 80 80 80 80 80 80 80 80 80 80 80
040: 0F 53 80 80 80 80 80 80 80 80 80 80 80 80 80 80
. . .
200: 42 41 53 49 43 0D 80 80 80 80 80 80 80 80 80 80
210: 46 49 4C 45 53 0D 80 80 80 80 80 80 80 80 80 80
220: 46 49 4C 45 53 20 31 0D 80 80 80 80 80 80 80 80
230: 4C 49 4E 45 45 44 49 54 0D 80 80 80 80 80 80 80
240: 4D 4F 44 45 4D 50 0D 80 80 80 80 80 80 80 80 80
```

(3b)

ADDRESS	KEY	CODE	WORDSTAR COMMAND
000–00F	0	CNTRL-R	SCROLL DOWN
010–01F	1	CNTRL-C	SCROLL UP
020–02F	2	CNTRL-Q C	BOTTOM OF TEXT
030–03F	3	CNTRL-Q R	TOP OF TEXT
040–04F	4	CNTRL-O S	SET LINE SPACING

ADDRESS	KEY	COMMAND STRING
200–20F	0	BASIC
210–21F	1	FILES
220–22F	2	FILES 1
230–23F	3	LINEEDIT
240–24F	4	MODEMP

Figure 3: *(a) A dump of a portion of the EPROM the author uses. Notice that each sequence starts on address xx0, continues to xxF, and is terminated by a hexadecimal 80. Although the EPROM actually holds sequences for two sets of function keys—the first set between 000 and 13F, the second between 200 and 33F—only the first five sequences of each set are shown here. (b) These two tables show what is actually stored in each key sequence.*

QUANTITY	PART	QUANTITY	PART
1	74193	1	0.01 μF
1	74121	2	0.1 μF
2	74LS244	1	1 μF
1	74C923	1	10 μF 16V
1	2716	1	4.7k resistor
1	555	2	10k resistor
2	7400	1	100k potentiometer
1	24-pin IC socket	1	SPST toggle switch
3	20-pin IC socket	1	Project board
1	16-pin IC socket	1	20-key keyboard
3	14-pin IC socket	1	Enclosure
1	8-pin IC socket	Miscellaneous connectors	

Figure 4: *A parts list for the keyboard-splitter and function-key-generator circuits.*

(continued)

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The function-key generator will produce up to 15 keystrokes for any given key press.

Figure 3 is a hexadecimal dump of portions of the EPROM. My design uses S1 to switch between two different code sets. The first set of codes is stored between addresses 000 and 13F and consists of WordStar commands. The second set goes from 200 to 33F and contains CP/M and BASIC commands. In the lower address section, we see in line 020 an 11 43. This equates to a "Control-Q C," the WordStar command to move to the bottom of the file. In the upper address section, look at line 220 and you will see 46 49 4C 45 53 20 31 0D, which equates to "FILES 1 <CR>". Both sequences are generated by the same key, but with switch S1 set to a different position. It is a good idea to get an ASCII chart and make a list of the codes you want to use.

Conclusion

You can expand the function-key generator. The design I have presented here uses 20 keys with two sets of codes for each, and each key generator provides up to 15 valid keystrokes (see figure 4 for a list of parts). By adding a second 74193, you can increase the number of keystrokes to 32, 64, or 128 per set. A 64-keystroke set would require 12 bits of address or a 2764 to hold all the output codes. Also, by using a three-position switch at S1, you could expand to three sets of codes per key. However, this would require a 2732 EPROM in place of the 2716.

The function-key generator is a very useful tool for almost any application, from word processing to general programming. In fact, I used it to help me write this article. ■

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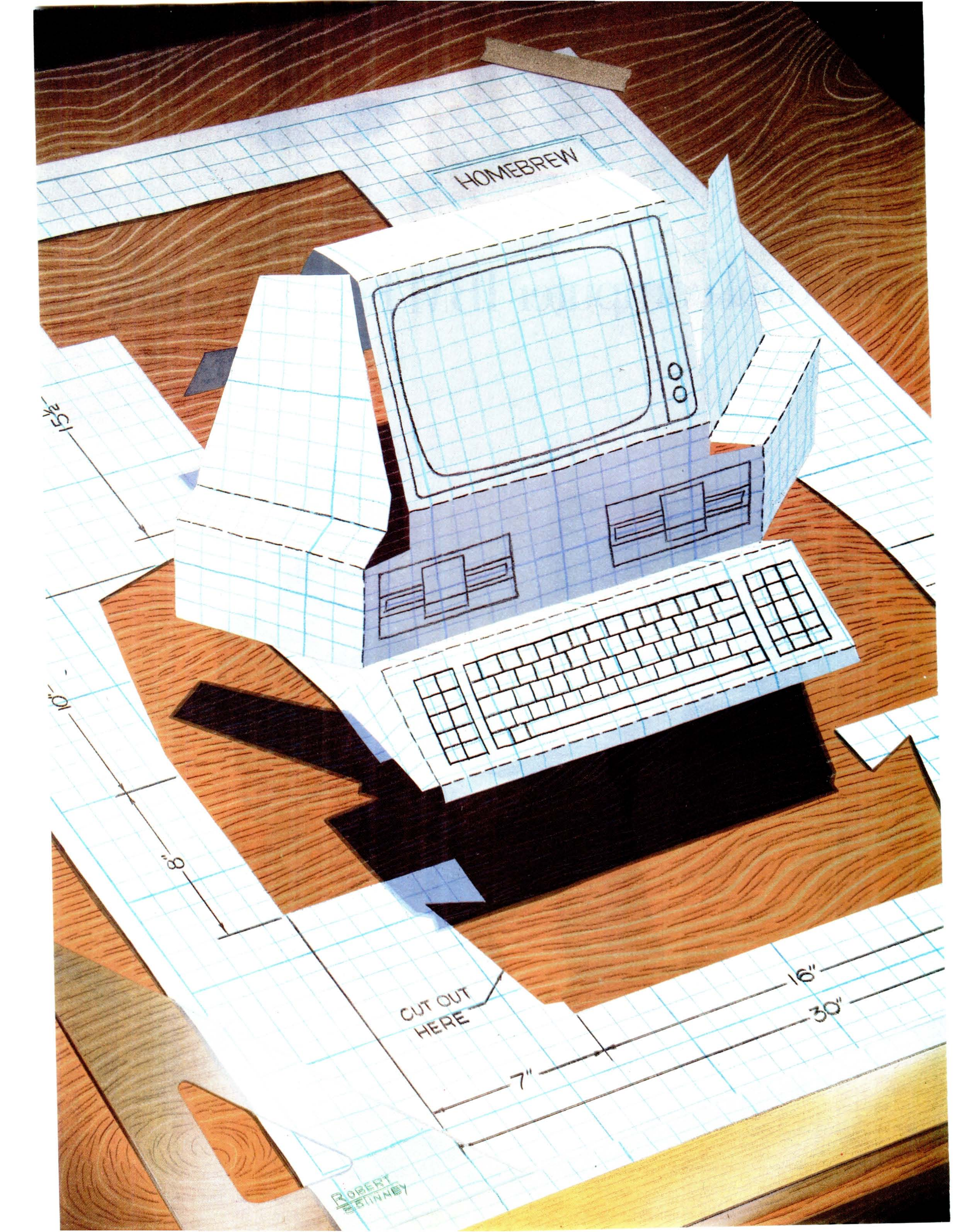
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Reviews

TWO SYSTEM REVIEWS lead off this month's section. The transportable Kaypro 16 is IBM PC XT-compatible and has many standard features at a reasonable cost. Author Steve McMahon discusses this machine's strong and weak points. Associate Editor Donna Osgood reviews the Osborne 3, an IBM PC-compatible midsize portable system that doesn't include any extras.

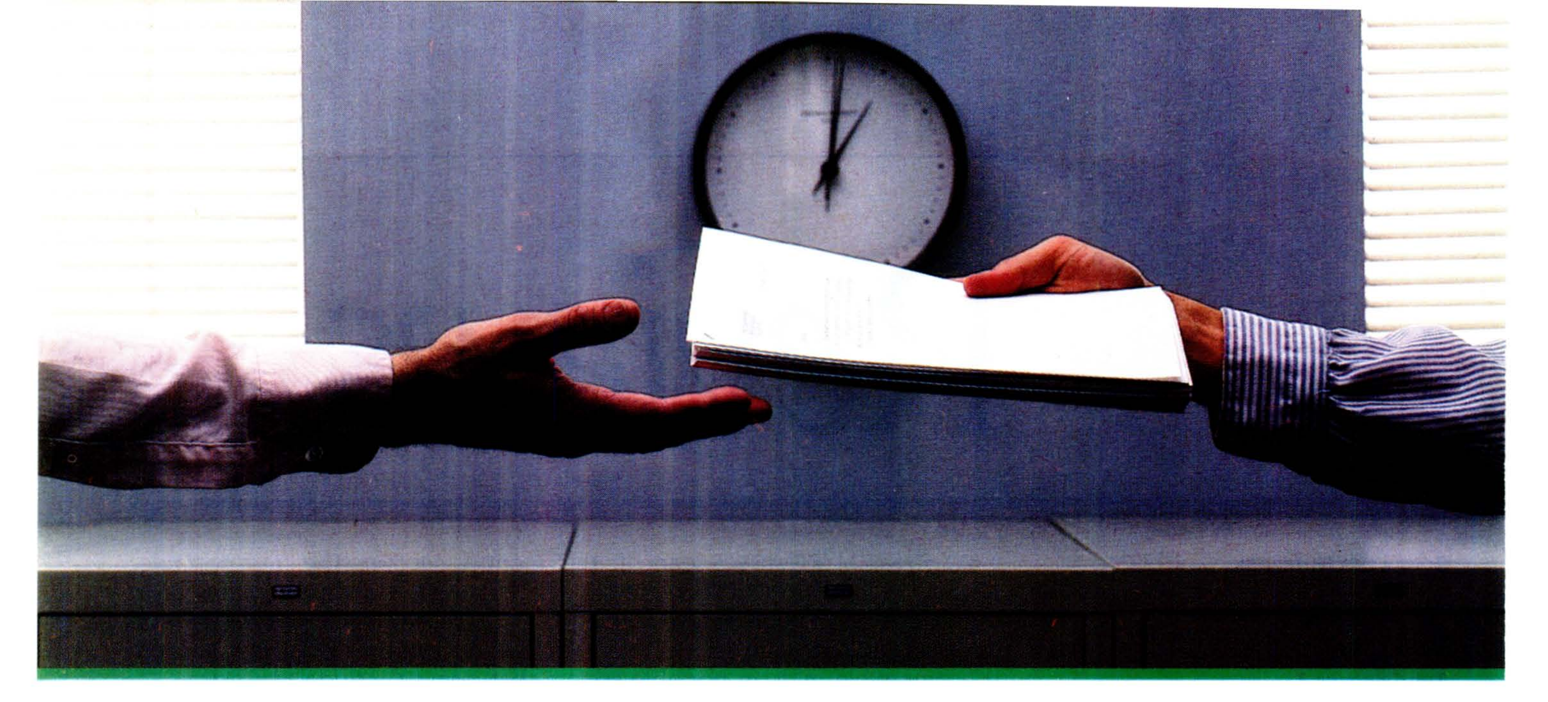
WordStar 2000 is an enhanced version of the classic word processor. Malcolm C. Rubel explores its capabilities and concludes that it is easier to learn but more difficult to use than the original. Rubin Rabinovitz reviews a WordStar competitor, XyWrite II Plus. This package has some sophisticated features, including a redefinable keyboard, macro routines, and programming capability, but it might be a challenge for the less experienced user.

A pair of database managers for the Macintosh completes September's software reviews. Both programs take advantage of the Mac's pull-down menus, icons, fonts, and other novel characteristics. Scott L. Norman describes Filevision's unique emphasis on graphics in data management. Jeffrey M. Jacques's review of DB Master indicates that it is a straightforward, easy-to-use database manager; however, it needs several improvements to become excellent Macintosh software.

The Paradise Systems Modular Graphics Card gives the IBM PC user both monochrome and color capability in a single add-in product. It also lets you plug in several modules to support other functions, such as serial and parallel ports, a floppy-disk-drive controller, and extra RAM. Author Harry Krause has been using the card for months with very good results.

Commodore 64 user Warren Block reviews RAMDISK-64, an expandable 64K-byte RAM disk with a $149 price tag. This product provides a considerable increase in speed over Commodore's 1541 disk drive.

In our final hardware review, David L. Salahi reports on the Keyport 717 for the Apple II family of microcomputers. A programmable keyboard with 717 key locations, the Keyport can greatly improve the Apple's user interface.



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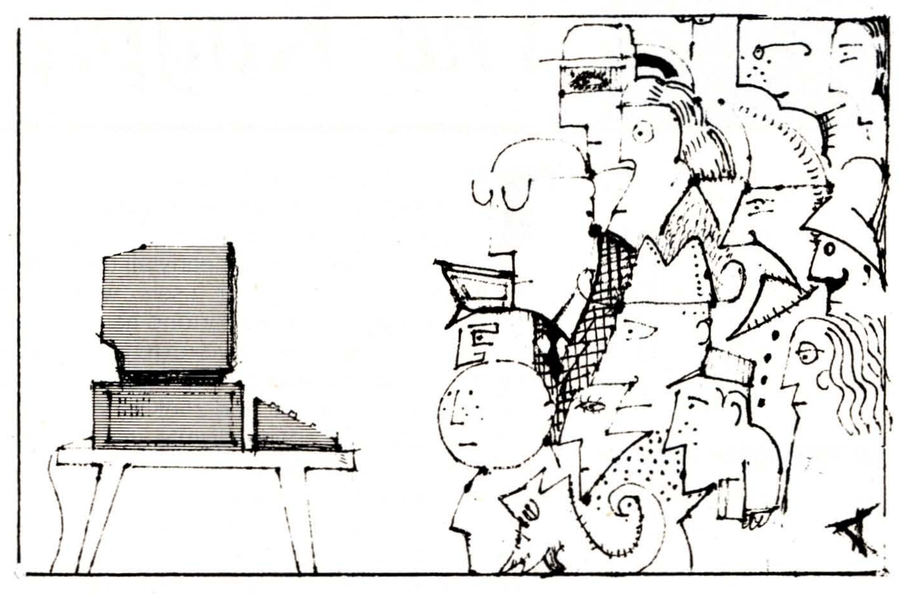
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Hewlett-Packard has come up with an interesting implementation of the less-is-more approach to product development with its Portable Plus, a new version of the HP 110. HP says it's like buying a stripped-down car and putting on the options you want instead of settling for the dealer's collection of prepackaged goodies.

The whole idea of custom configuration is near and dear to the hearts of most microcomputer users, and the more freedom the individual has, the better, but the Portable Plus's equation is somewhat complex. First of all, you get a fairly basic system (no applications software) for about the same price as the HP 110. All the features you might want to add will bring the cost up proportionately. This is not a way of getting the HP 110 of your dreams for the same price tag as on the model-year closeout.

On the other hand, the components of the basic system, as well as the available options, all indicate that a good deal of thought and preparation went into the design and choices. For example, you don't get a modem with the Portable Plus (you do with the HP 110). But if you decide you want this option, you get a 300/1200-bps Hayes-compatible modem and functional software instead of the 300-bps modem and cranky software included as part of the HP 110's standard equipment. If you want to write, you get Microsoft Word as an option instead of MemoMaker. I use both of these options, and they both represent a substantial improvement. I don't use spreadsheets much, so I don't have an opinion about Lotus 1-2-3 versus Multiplan.

The Portable Plus has 512K bytes of main memory. You configure it from a menu, so your ROM-based software has enough to run and you're left with the remainder as work space. Microsoft Word for the Portable Plus takes up 140K bytes.

One thing that is both welcome and slightly ironic is the improvement in the documentation. Everything I have wanted to do with the portable machine was clearly and concisely spelled out. The irony is this: With the improved software and hardware, I needed to refer to the documentation less. All things considered, however, I'd much rather have good documentation that I needed to consult infrequently than an industry-standard cryptic manual that I needed to have grafted onto the side of my arm.

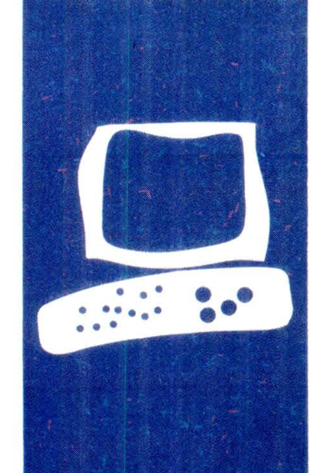
Low-cost, high-volume mass storage is starting to take some interesting turns now that laser discs are being seen more often. At the National Computer Conference in Chicago, Optotech Inc. of Colorado Springs, Colorado, was showing to OEMs a write-once/read-forever 400-megabyte 5¼-inch unit integrated into an IBM Personal Computer. Dealers could get one for $5000 "almost immediately." The normal small-quantity price was $3000. Optotech said large-volume orders could bring the price down to less than $1000 per unit. National Memory Systems of Livermore, California, was reported to be the only customer as of mid-July.

What should be interesting to observe in the coming months is (1) whether or not laser discs with hundreds of megabytes of storage catch on with users, and (2) if they do, whether or not this further drops the price of magnetic hard disks. We've already seen and reported on 30-megabyte 5¼-inch hard disks that cost less than $1000. If people can suddenly get 400 megabytes for the same price, it could increase their choices. One thing that might come between many users and the ability to take advantage of really high-volume mass storage could be the limitations of their machines.

Priam Corporation of San Jose, California, was showing to OEMs at NCC a 191-megabyte unformatted 5¼-inch hard disk. The company pointed out that an IBM PC AT could interface with the hard disk but couldn't address its entire capacity. If you happen to have a high-end CAD/CAM intelligent workstation, you're home free.

—*Glenn Hartwig, Technical Editor, Reviews*

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The Kaypro 16

A low-cost portable compatible with the IBM PC

BY STEVE MCMAHON

The Kaypro 16 is an IBM PC-, PC XT-compatible computer packaged in a transportable box (see photo 1). The 16 comes complete with nearly all the components most computer users will need—two floppy-disk drives or one hard-disk and one floppy-disk drive, extensive software, communications and printer adapters, a video monitor, and 256K bytes of RAM (random-access read/write memory)—at a highly competitive price of $2295 ($3295 for a hard-disk system).

While comparing retail prices, you might discover that you can buy a hard-disk PC XT without software or a floppy-disk IBM PC with software for the price at which Kaypro provides both hard disk and software. Many users will appreciate the Kaypro 16's limited portability as a side benefit.

The Kaypro 16 (I reviewed the hard-disk model) comes in one package and is quite easy to set up. Its keyboard unlocks to reveal the built-in monitor and floppy-disk drive. Connect the keyboard to the back of the computer, prop the main unit up on its attached stand, plug it in, and it's ready to go.

Now the real fun begins: The 16 comes with a lifetime supply of gray paperback manuals (I counted 13). Fortunately, on its cover one of them bears the words "Read me first"; it contains setup information. Unfortunately, it's the worst manual of the lot. Some of the setup information was obviously written with a Kaypro computer other than the 16 in mind.

The 16 also comes with nine disks containing MS-DOS and the computer's extensive bundled software. When you place the first of these disks in the floppy-disk drive and turn the computer on, the Kaypro 16 formats the hard-disk drive and auto-loads the software bundle onto the hard disk, efficiently organizing the programs into several functionally defined subdirectories. This auto-load process prompts you to supply the appropriate disks and finishes by setting up the elaborate menu system to automatically execute whenever you turn on the 16.

MENUS

The hard-disk Kaypro 16 features a menu system that lets you use the machine's resources without immediately learning the complexities of the MS-DOS subdirectory system. The master menu, which appears when you first turn on the machine or restart it, presents you with a list of functionally organized submenus. When you select a submenu by positioning a reverse-video bar over it and hitting the return or right-arrow key, the computer displays the submenu's options beside the main menu, which is dimmed. On the right side of the screen, the system also presents helpful explanations of what each menu selection will do.

The hard-disk menu system allows access to word-processing and other applications, DOS utility programs, and a large collection of interactive tutorial programs from MicroPro. These tutorials cover everything from using the word processor and database programs included with the 16 to getting used to the computer and keyboard.

COMPATIBILITY

I'm convinced that the Kaypro 16 is substantially compatible with the IBM PC. I had no problem running popular programs like Microsoft's Flight Simulator and Lotus 1-2-3, and such intimate DOS utilities as Borland International's SideKick, keyboard-redefinition programs, and RAM-disk software. The 16's BIOS (basic input/output system), designed by Phoenix and also used in IBM clones from Tandy and AT&T, appears to mimic the IBM PC's BIOS service for service.

As with any PC imitation, it is wise to check before you buy and make sure that any vital program you need to run will operate properly on the 16. Programs where problems are possible include those that are subtly copy-protected, that make direct use of the IBM BASIC read-only memory chip (usually graphics games), or

Steve McMahon (POB 3262, Berkeley, CA 94703) is an independent software developer specializing in systems for small newspapers.

that might depend on unique hardware characteristics of the IBM PC (such as a program that requires hardware or firmware modifications). The only program I couldn't run on the 16 was a copy-protected game that also does not run on several other compatibles.

KEYBOARD

The Kaypro 16 has the IBM PC's unpopular keyboard layout (see photo 2). The return and left shift keys are small and placed differently than many touch-typists would expect. Typists with smaller hands might have to move their fingers away from the home keys to strike the return key.

The 16's keyboard offers an improvement over the PC and PC XT keyboards in another respect: Kaypro provides indicator lights for the Caps Lock and Num Lock keys. However, each light's status is apparently determined by the keyboard, rather than through software control by the BIOS. This means that it's possible to get the keyboard lights out of sync with the rest of the computer. Nonetheless, the indicator lights should prove convenient for most users.

The keys themselves have a very short throw and provide distinct tactile feedback. The noise they make is generally soft, with the exception of the space bar.

VIDEO DISPLAY

The Kaypro 16's built-in green-phosphor display incorporates the strong and weak points of the IBM PC graphics standard. You can get medium-resolution (320 by 200 pixels) and high-resolution (640 by 200) graphics modes, and a tremendous collection of software is available for them.

However, as with the IBM PC graphics standard, the text this graphics monitor displays is comparatively poor (see photo 3). And when poorly defined characters are squeezed into a 9-inch display, as they are in the 16, the result is a screen that is close to unacceptable for long periods of text work. The 16's low-quality text display is ironic: All Kaypro's other computers that are not IBM PC-compatible currently feature text displays that would be better for extended writing or editing sessions.

The 16's monitor shares another common deficiency of IBM PC-type graphics displays: It flickers when rapidly updated by software that directly manipulates the memory-mapped video. To avoid this problem, many programs slow down their video updating when they detect that an unimproved graphics monitor (as opposed to improved graphics monitors, such as Compaq's) is in use. The result of this slowdown is noticeable and can be annoying if you are accustomed to the high-performance scrolling and paging available on high-resolution monochrome monitors or improved graphics monitors.

Another drawback is the placement of the monitor's intensity control. Kaypro put this important control on the 16's back panel

(continued)



Photo 1: *The Kaypro 16, an IBM PC- and XT-compatible featuring two floppy-disk drives or one floppy-disk and a 10-megabyte hard-disk drive (the latter combination is shown).*

and then made matters worse by blocking it off with a plastic post (one of two meant to hold a cable when you transport the computer). In my experience, video intensity is not a control that you set once then forget about. I adjust it to different levels in the morning, afternoon, and night and nearly always prefer different brightness levels from others who work on the same machine. The Kaypro 16 makes such adjustments difficult.

A relatively minor problem is that I could distinguish only about four different shades of video attributes on the green-phosphor screen. This meant that a couple of programs didn't look as good as usual. If you have an application requiring that more than a few video attributes be distinguishable, the 16's built-in monitor might not be satisfactory.

You can solve the problems with the Kaypro 16's small screen in a simple though expensive way. You can hook the unit to an external monitor through the built-in RGB (red-green-blue) or composite-type video ports. On a larger monitor, the text resolution would not cause an eyestrain problem and, if you use an RGB color monitor, many more video attributes should be distinguishable. Presumably you could use the 16 with a larger, high-quality monitor at a home base, so you would have to use the built-in monitor only in the field. (Problems with flickering or slow video update do not go away with an external monitor; that's a fault of the video-board design, not the built-in monitor.)

Photo 2: *The Kaypro 16 keyboard with 83 keys, 10 IBM PC-compatible function keys, calculator keys, and Caps Lock and Num Lock indicator lights.*

Photo 3: *Text display on the Kaypro 16.*

PORTABILITY

You can prepare the Kaypro 16 for transport fairly easily. You put a transport card in the floppy-drive opening, lock the keyboard over the monitor and floppy drive, fold up the attached stand, and wrap the keyboard and power cables around posts at the rear of the computer. Plastic caps are included to cover the ends of the keyboard cable. You can carry the computer by the handle at its rear, and it will fit under many airline seats.

The problem is that the 16 is no lightweight. At 33 pounds, it's hard work to carry it anywhere. Also, the handle is nothing more than a flat metal strip with plastic around it. This type of handle wasn't much of a problem with the Kaypro 2, which weighed in at 26 pounds, but it is unsatisfactory on the heavier Kaypro 16.

Another transport problem arises from the fact that the 16 has two sets of vents that leave its interior vulnerable to moisture and dust. Also, the I/O (input/output) ports and reset switch on its side are completely unprotected. I suggest you budget in the cost of a good case if you intend to use the 16 as a portable.

The 16's optional, built-in, half-height, 5¼-inch Winchester hard-disk drive is double shock-mounted to withstand the bumps that inevitably come with transport. According to Kaypro, the 16 parks the read/write heads of the hard disk in a data-free landing zone whenever they're not in

(continued)

AT A GLANCE

Name
Kaypro 16

Manufacturer
Kaypro Corp.
533 Stevens Ave.
Solano Beach, CA 92075
(619) 481-4300

Size
18 by 8 by 15 inches, 33½ pounds

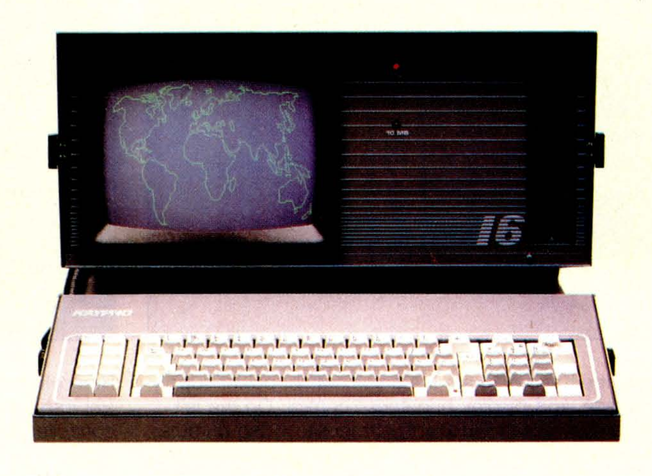
Components
Processor: Intel 8088
Memory: 256K bytes standard, expandable to 640K bytes
Mass storage: Two 360K-byte double-sided double-density 5¼-inch floppy-disk drives or one floppy drive and a built-in 10-megabyte hard-disk drive
Display: 9-inch green phosphor, 80 characters by 25 lines, composite and RGB video output connectors
Keyboard: Detached, 83 keys, 10 function keys, separate calculator keys, Caps Lock and Num Lock indicator lights
Expansion: One available IBM PC-compatible slot
I/O interfaces: Asynchronous serial and parallel printer ports

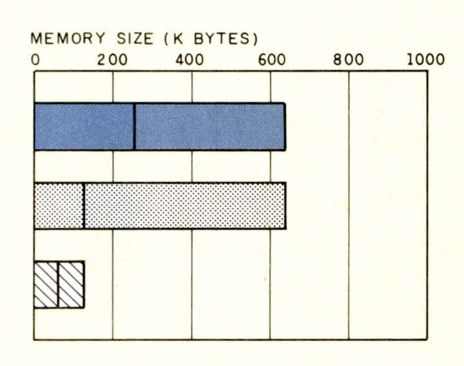
Software
MS-DOS, WordStar, MailMerge, CalcStar, InfoStar+, MITE, GW-BASIC, and tutorials

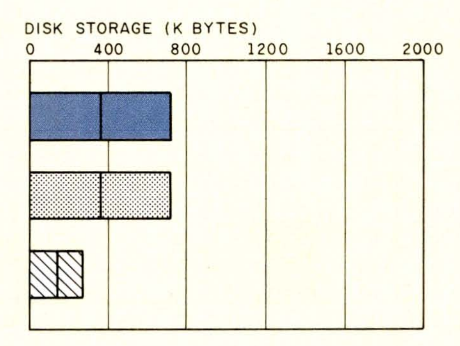
Documentation
69-page *Kaypro 16 User's Guide*, separate manuals for MS-DOS and each of the bundled software packages

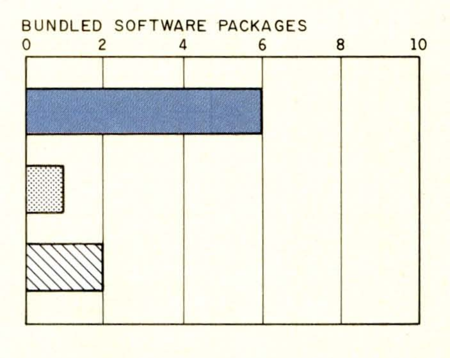
Price

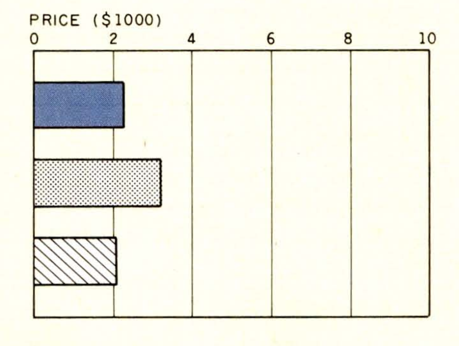
Dual-floppy system	$2295
10-megabyte hard-disk system	$3295



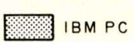








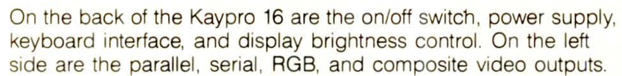




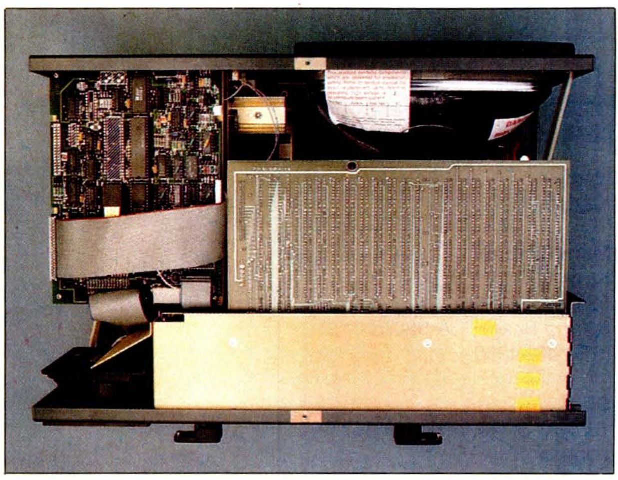


The Memory Size graph shows the standard and optional memory available for the computers under comparison. The Disk Storage graph shows the highest capacity for a single floppy-disk drive and the maximum capacity for each system. The Bundled Software Packages graph shows the number of software packages included with each system. The Price graph shows the list price of a system with two floppy-disk drives, a monochrome monitor, graphics and color display capability, a printer port and a serial port, 256K bytes of memory (64K bytes for the Apple IIe), the standard operating systems for the computers under comparison, and the standard BASIC interpreter for each system.

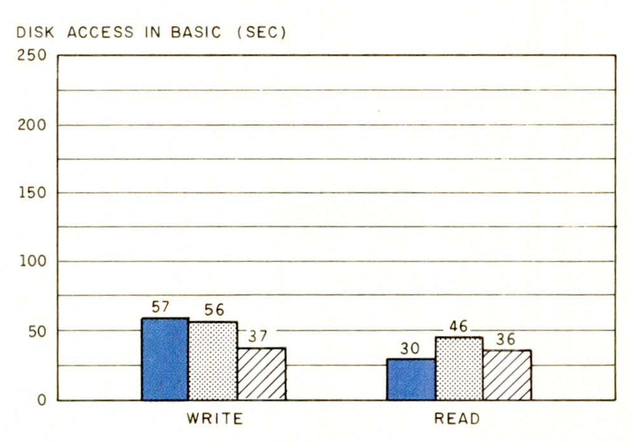


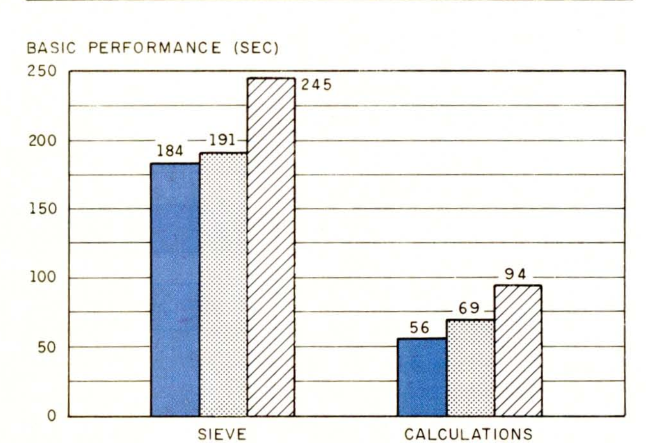


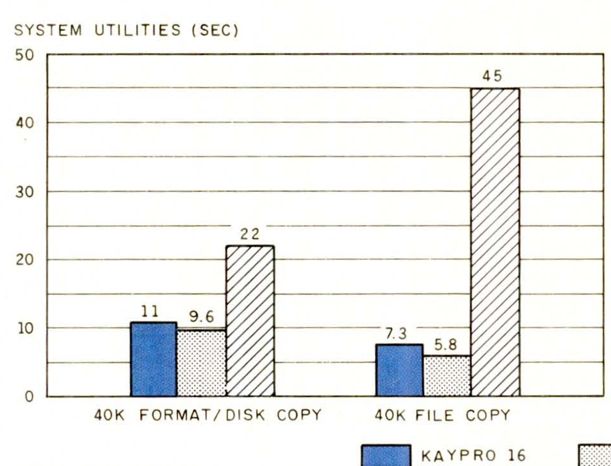
On the back of the Kaypro 16 are the on/off switch, power supply, keyboard interface, and display brightness control. On the left side are the parallel, serial, RGB, and composite video outputs.

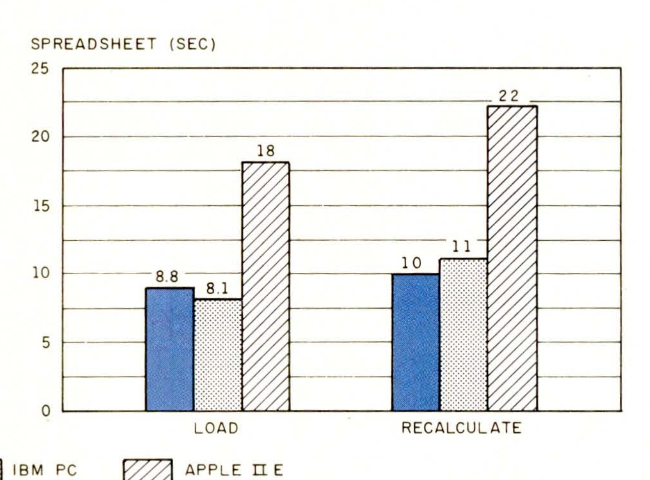


Removing the Kaypro 16 from its case reveals the expansion slot cage (bottom), the main memory board, and the hard-disk controller (left front).









KAYPRO 16 IBM PC APPLE II E

The graphs for Disk Access in BASIC show how long it takes to write and to read a 64K-byte sequential text file to a blank formatted floppy disk. (For the program listings, see June 1984 BYTE, page 327, and October 1984, page 33.) The Sieve columns in the BASIC Performance graph show how long it takes to run one iteration of the Sieve of Eratosthenes prime-number benchmark. The Calculations columns show how long it takes to do 10,000 multiplication and 10,000 division operations using single-precision numbers. The System Utilities graph shows how long it takes to format and to copy a disk (adjusted time for 40K bytes of disk data) and to copy a 40K-byte file using the system utility programs. The Spreadsheet graph shows how long it takes to load and recalculate a 25- by 25-cell spreadsheet where each cell equals 1.001 times the cell to its left. Microsoft Multiplan was used on the IBM PC and Apple IIe; CalcStar was used on the Kaypro. Tests for the Apple IIe were done with the ProDOS operating system, except for the spreadsheet test, which was done with DOS 3.3. The IBM PC was tested running under PC-DOS 2.0, and the Kaypro 16 was tested running under MS-DOS 2.11.

use. If that's true, minor jiggles won't endanger data on the disk.

I'm still nervous about transporting a hard disk—the potential for expensive damage is great if anything goes wrong. The *Kaypro 16 User's Guide* offers no reassurance: It contains no information about preparing the 16 for transport, nor does it suggest what the machine should or should not be able to withstand.

EXPANSION

The 16's internal design is different from any other PC-compatible I've dismantled. The main board is upside down (chips down) at the top of the machine, with the expansion cage below it and toward the back of the computer (see photo on opposite page). The expansion cage and main board are held in place by four screws in the computer's back panel.

Another surprise is that the main board does not actually contain the heart of the computer. The 8088 microprocessor and nearly all of its support chips are on the board filling the first (rearmost) of the IBM PC-compatible expansion slots on the main board. It turns out that the motherboard contains very little but memory chips and slots, some hard-disk adapter circuitry, and the bus and expansion slots. Unfortunately, the most inaccessible of the 16's components are the ones you need to get at to expand its capacities.

The Kaypro 16 has one free expansion slot. (Three of four slots are occupied by the logic board, floppy-disk controller and serial/parallel I/O board, and video board.) Also, it has sockets for an additional 256K bytes of RAM on the main board and an 8087 numeric coprocessor chip on the logic board. To add either of these you must remove the entire main board and expansion-cage assembly and unplug seven cables.

This process is not documented in the *Kaypro 16 User's Guide*, nor does the guide contain instructions for setting the DIP (dual in-line package) switches on the logic board to let the computer know about the changes. Most users should not try expansion of the 16 on their own but should reconcile themselves to paying a dealer to do it.

SOFTWARE

The 16's software bundle is extensive, including GW-BASIC and word-processing, spreadsheet, database, communications, and menu-construction packages. Unfortunately, the programs are of very uneven quality and might provide some unpleasant surprises. I liked only one program (MITE, the communications package) enough to consider using it regularly.

MicroPro's WordStar, the word processor, is a serviceable program that suffers only in comparison to the many editors available for PC-compatibles that are both more versatile and easier to use. Not so with CalcStar, the spreadsheet program: It is the slowest, clumsiest program of its type I've ever tried to use on an IBM PC-type computer. The principal deficiency of the bundled database program, InfoStar+, is its formidable—and, in my opinion, unwarranted—complexity. Its training and reference manuals run to hundreds of pages.

MITE's strong point is that it lets the user set up parameter files, each of which can contain information such as data-transmission characteristics, phone number to dial, log-on procedure, and number of times to retry if busy for each bulletin board or service you call regularly. The communications program's weak point is that Mycroft Labs has not yet adapted either the user interface or the manual sufficiently in transferring the program from CP/M to MS-DOS.

USER'S GUIDE

Most of the massive quantity of documentation provided with the Kaypro 16 is reprinted from the original MicroPro and Microsoft manuals for the bundled software. The only documentation items provided specifically for the 16 are the 69-page *Kaypro 16 User's Guide* and a stapled leaflet containing installation instructions for the MicroPro software.

I found the *User's Guide* grossly inadequate: It was poorly organized, omitted important subjects, and was occasionally incorrect about what it did discuss. A section labeled "Maintenance" contained little more than instructions on how to clean the fan filter. Explanations of MS-DOS commands were brief, sometimes misleading, and in at least one case would result in a syntax error if followed precisely. Kaypro has received lots of criticism in the past concerning documentation; it's disappointing to see so little improvement.

SOME KINKS

One difficulty I had with the Kaypro 16 resulted from the fact that the 16's serial communications port was a 9-pin female connector rather than the conventional 25-pin. This meant that not one cable out of my collection would connect my modem with the 16. Any modem with a built-in serial cable will need modification or an extra cable to work with the 16. The reason for this nonstandard connector is that the port shares external space with a 25-pin parallel connector, which leaves no room for the standard serial connector.

Perhaps a more serious complaint about the serial port is that it is positioned immediately next to the 16's RGB port, which is also a female 9-pin. Neither is labeled. Fortunately, Kaypro has stated that it is changing the connector to a 9-pin male, making it compatible with the 9-pin serial connector on the PC AT.

Another mild source of annoyance is the combination of a relatively loud fan and a quiet speaker, which makes it hard to hear the sounds that some programs generate.

CONCLUSION

The Kaypro is a serviceable and economical alternative to the IBM PC or PC XT, particularly if you can use the bundled software and you need limited portability. But the computer does have a variety of rough spots that should be weighed against its comparatively low price. Low text-display quality, limited expansion possibilities, uneven software quality, and poor documentation all deserve scrutiny from potential users. ■


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S·Y·S·T·E·M R·E·V·I·E·W

The Osborne 3

A midsize, no-frills portable

BY DONNA OSGOOD

The Osborne 3 is an IBM PC-compatible midsize portable computer based on the 80C86—a CMOS (complementary metal-oxide semiconductor) version of the 8086—running at 3.5 MHz. No applications software is bundled with the computer, nor is a battery included. Osborne ships the basic machine and expects value-added dealers to provide the battery, RAM upgrade to 512K bytes, modem, video cable, external monitor, applications software, and other things that make up a workable system.

The O3 has two 5¼-inch floppy-disk drives, 256K bytes of RAM (random-access read/write memory), and a liquid-crystal display (LCD) in a package that weighs less than 12 pounds (see photo 1).

HARDWARE

At its weight and with the dimensions of 9½ by 13 by 5½ inches (closed), the O3 is in a class between transportables and briefcase computers. A removable shoulder strap fits into slots in the machine's sides. With the shoulder strap adjusted so that the slanted front panel fits over your hip, the O3 is very easy to carry, without the uncomfortable corners a square-profile machine has.

The front panel folds down to become the keyboard, revealing the screen embedded in the body of the computer. Two disk drives occupy the right side of the machine, and the battery slot, power jack, switch, and screen-contrast control are on the left. The rear panel contains the serial and parallel connectors.

The built-in screen is an 80-character by 16-line LCD with 480 by 128 addressable pixels (see photo 2). The character font is simple and readable, 5 by 7 pixels in a 6- by 8-pixel matrix, with true descenders. Under ordinary office lighting conditions (fluorescent light source from above), the screen is just readable. Sunlight coming from any direction washes it out completely, however. The screen is fixed; you can't tilt it to suit your viewing angle. The contrast control provides some flexibility, but even at best the screen is a poor substitute for a CRT (cathode-ray tube) screen.

Osborne offers a partial solution: an external video adapter. The 1½- by 9½- by 6½-inch box includes a parallel port to replace the one it uses, so both a printer and an external monitor can be connected at the same time. On both monitors I tried, a Zenith monochrome and a USI Pi3, the picture was slightly larger than the screen, and a character or so was lost on each corner, even at optimum vertical and horizontal adjustment. This is not a problem on all monitors, but it is something to watch for.

The O3's keyboard (see photo 3) is a compressed and slightly rearranged version of the IBM PC's. Shift and Return keys, though small, are in the Selectric typewriter positions (with no annoying intervening keys). Scroll/Num Lock, Caps Lock, and Alt keys occupy the left side of the bottom row, with four cursor keys to the right of the space bar. The cursor keys serve as Home, End, Pg Up, and Pg Dn keys when used in combination with the Alt key. A calculator keypad is an overlay to alphanumeric keys on the right side of the keyboard, activated by the Num key. All alphanumeric keys repeat when held down.

Some of the IBM PC's keyboard problems are corrected in the Osborne. For example, the Prt Sc key, which causes a particularly frustrating delay when hit accidentally, is moved away from the home keys and works in combination with Alt.

A row of membrane keys above the keypad holds 10 function keys and 4 icon keys for the O3's built-in operations. Labels for the function keys appear on the screen when an application that supports them is running. This works well with the built-in applications, but function-key identifiers will not be visible when using a program such as WordStar, which puts them at the bottom of a 25-line screen. Shifting the screen back and forth from the top to the bottom

Donna Osgood is an associate editor for BYTE (425 Battery St., San Francisco, CA 94111).

of the page is enough trouble to outweigh the convenience of the function-key identifiers.

The keyboard panel needs to be supported on a solid surface—it jiggles unacceptably if it extends beyond the edge of a table or desk. Even with the keyboard well supported, letters occasionally skipped on both machines I used while writing this review. The R key was a problem on both machines.

Sources at Osborne assured me that the O3's keyboard buffer is as large as the IBM PC's. However, when I use multiple-keystroke commands, such as <Ctrl>JJ1, which is NewWord's command to change the help level, the last letter is often not accepted. Occasionally, the lag between striking a key and seeing a letter on the screen is noticeable.

The O3 is shipped with 256K bytes of RAM, expandable to 512K bytes. The built-in calculator, scheduler, terminal emulator, and map-display programs use 16K bytes of ROM (read-only memory). To hold appointment notes, 4K bytes of nonvolatile RAM is assigned to the scheduler.

A 100/220-volt AC-to-DC adapter supplies 15 volts DC. A standard nicad video-camera battery fits the O3, but it is not included. A full charge on the nicad battery should run the machine for about five hours. A recharge takes about eight hours, though the battery will trickle-charge while in use with the AC-to-DC adapter.

The O3 uses two double-sided one-third-height 5¼-inch floppy-disk drives (see photo 4). The drive doors spring open to partially eject the disks when pressed and released. The doors cover the drive openings completely, keeping dust at bay. The openings are designed to guide disks into place without a struggle. I had no trouble inserting and removing disks from the side of the machine without peering around to see what I was doing. A red light glows when a drive is running.

The O3 has both a parallel and a serial port. The RS-232C serial port uses the 8251, a CMOS chip manufactured by Oki, rather than the 8250 that is IBM's standard. A software front end in ROM makes the O3 compatible with CrossTalk, but some programs that talk directly to the serial port will not run.

The internal clock is backed by a battery and should keep time when the machine is unplugged. In one of the machines I used, however, the clock lost time when the machine had neither AC nor DC power turned on.

SOFTWARE

The only software bundled with the Osborne 3 is MS-DOS 2.11. BASIC is not included, nor are any applications programs. Three "executive productivity" programs are resident in ROM: an appointment book,

(continued)

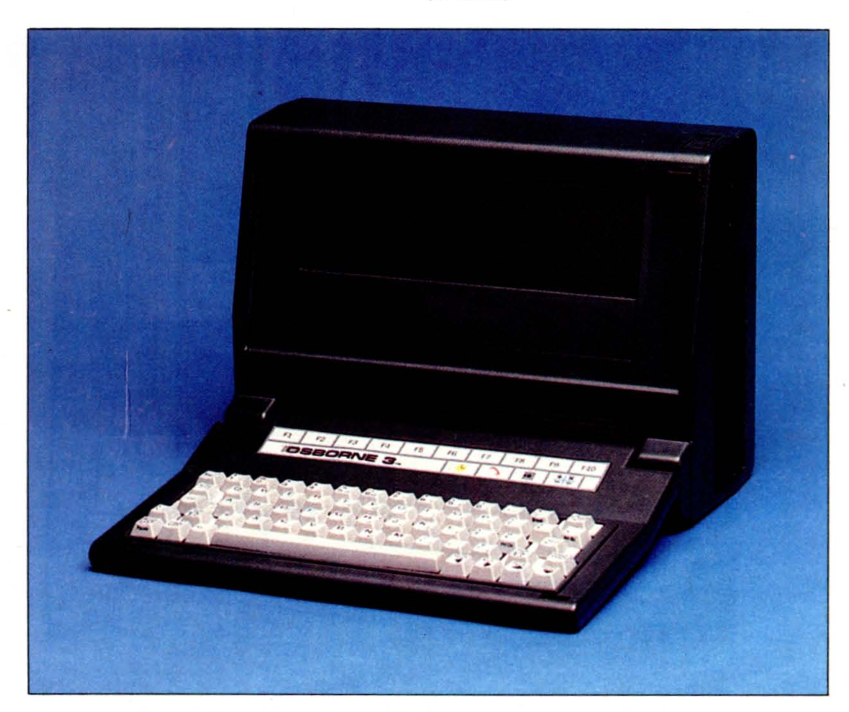


Photo 1: *The Osborne 3 with an 80-character by 16-line liquid-crystal display and two 5¼-inch floppy-disk drives.*

a calculator, and a terminal emulator program.

Using the Osborne 3

As the power comes on, the O3 displays a calendar, clock, and map of the world. By pressing a function key at the map screen you can reach the menu from which you set time and date, printer and modem parameters, and screen type. Another function key (labeled on the screen) gives you the appointment calendar (which can handle dates as far off as December 31, 2099). You can set an alarm (a flashing message and beep) to remind you of engagements.

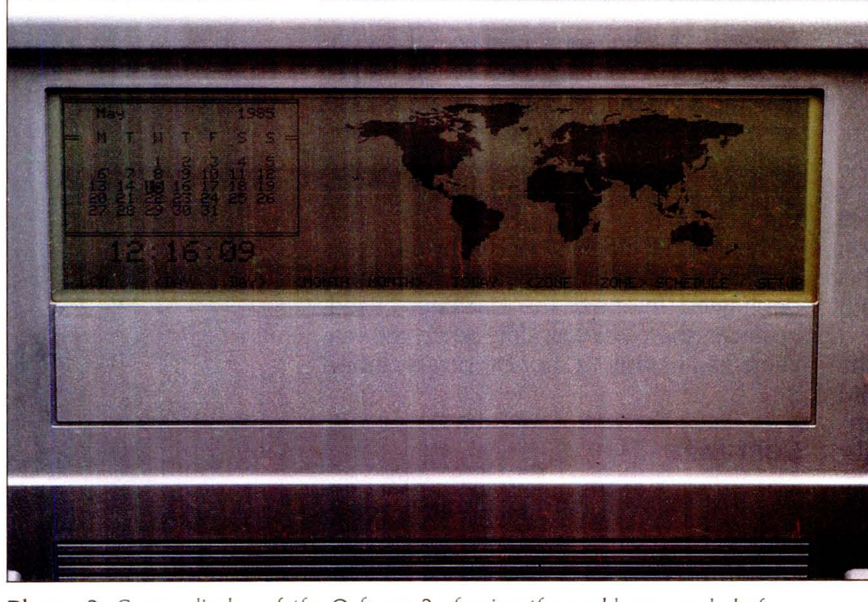


Photo 2: *Screen display of the Osborne 3 showing the world map and clock.*



Photo 3: *Close-up of the Osborne 3 keyboard shows the rows of special function and icon keys above the alphanumeric keys.*

To load a program from disk, you simply push the disk icon key. While you are using an application from disk, you can reach the O3's other built-in functions, like the calculator, terminal emulator, and calendar, by pushing their icon keys. When you have finished your digression, pressing the disk key returns the disk application to the screen.

Flying with the Osborne 3

If your reason for buying a portable computer involves travel, you will be concerned with the O3's performance on a plane. Its size and shape make it easy to stow under a seat. It fits well on a tray table and does not weigh enough to endanger the table's hinges. Be careful in the aisles, however. The O3 is no heavier than the average carry-on bag, but it is made of hard plastic with square corners, and it could do damage to someone if it slides around on your arm.

Airlines differ in their tolerance of portable computers on board, so check with your carrier before you plan to finish writing your big speech in the air. The O3 is rated with the FCC as a Class A machine, a rating that involves a less rigorous interference standard than Class B. Even so, using the computer in flight probably will not cause problems with the aircraft's equipment; Osborne reports that one airline pilot uses his O3 in the cockpit. On the other hand, if you wind up in Detroit when you were headed for Milwaukee, you might reconsider using your computer on planes.

Compatibility

The O3 is an IBM PC emulator. It uses a software front end to simulate the operation of an IBM PC. This means that no program that makes calls directly to hardware will work, which eliminates many copy-protected packages. The O3 doesn't have graphics capabilities, even when using an ex-

(continued)

AT A GLANCE

Name
Osborne 3

Type
Portable computer

Manufacturer
Osborne Computer Corp.
42680 Christy St.
Fremont, CA 94538
(415) 887-8080

Size
9½ by 13 by 5½ inches closed; 11 pounds, 15 ounces without battery or AC adapter

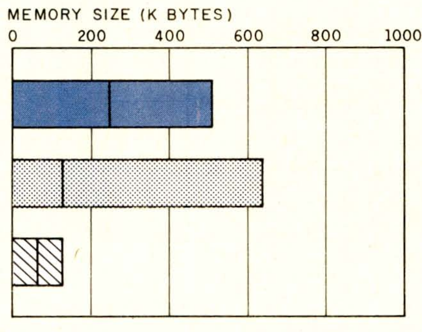
Components
Processor: 80C86 16-bit, 3.5 MHz
Memory: 256K RAM (expandable to 512K using 256K DRAMs), 16K ROM, 4K nonvolatile RAM
Disk storage: Two 360K 5¼-inch floppy-disk drives
Display: 80-character by 16-line LCD; 480 by 128 addressable pixels with external video adapter
Keyboard: 63 keys, including 4 cursor keys, 10 flat-membrane function keys, and 4 icon keys
Power: 15-volt DC from a 100/220-volt AC-to-DC adapter; can use standard nicad video-camera battery (not included)

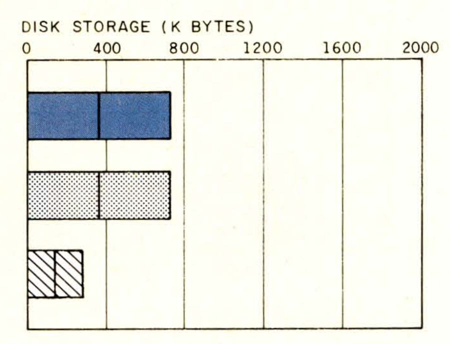
Software
MS-DOS 2.11; scheduler, calculator, and terminal emulator in ROM

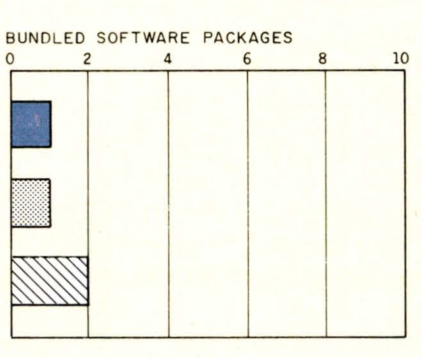
Documentation
User's guide, 57 pages; manual for appointment calendar, 22 pages; MS-DOS user's guide, 188 pages

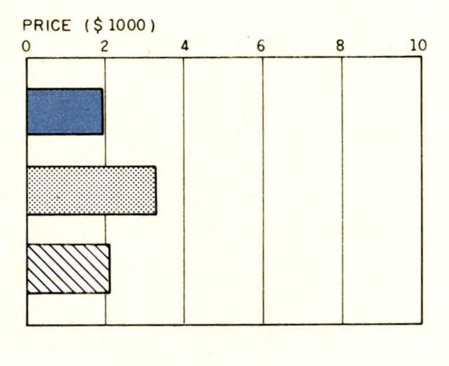
Price
$1895 for two drives and 256K RAM











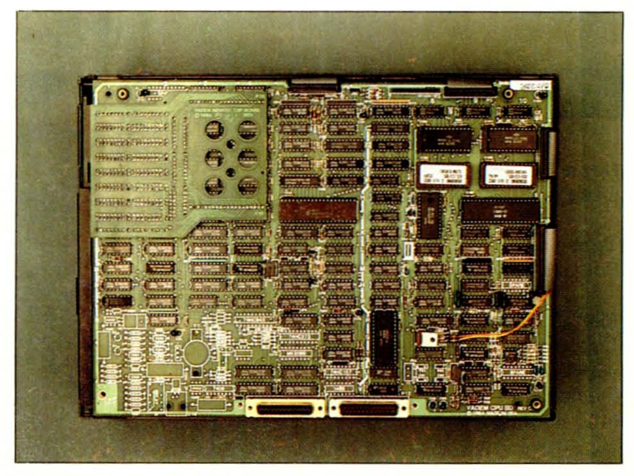




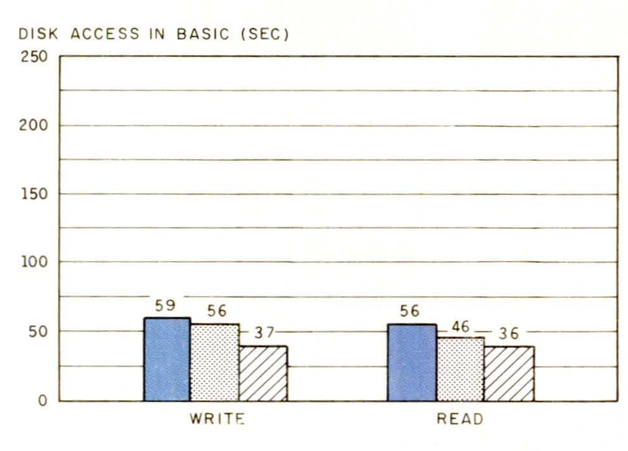
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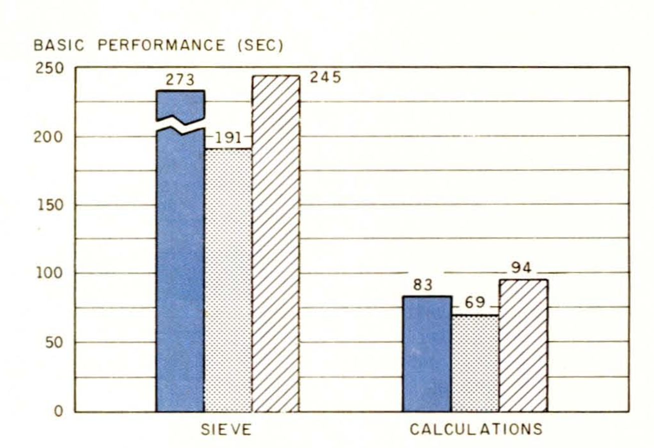


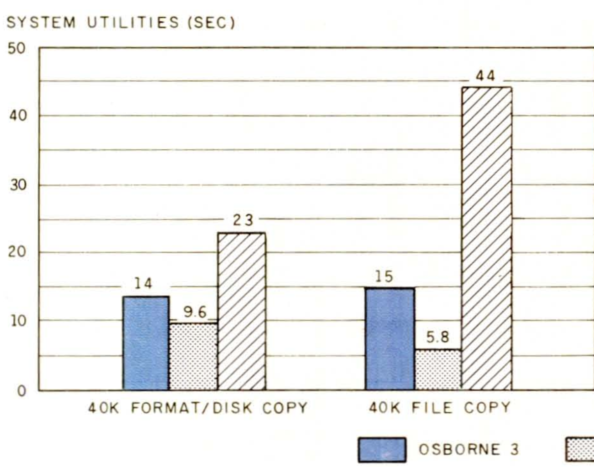
The rear of the Osborne 3 holds the parallel and serial ports.

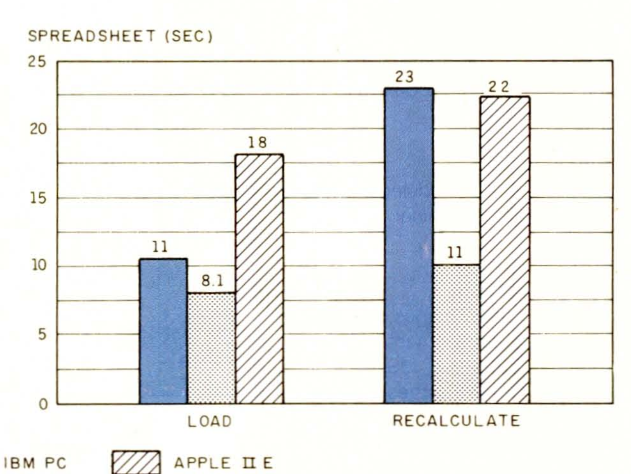


Inside the Osborne 3. Parallel and serial connectors are at the bottom.









The graph for Disk Access in BASIC shows how long it takes to write and read a 64K-byte sequential text file to a blank formatted floppy disk. (For the program listings, see "The Chameleon Plus" by Rich Krajewski, June 1984 BYTE, page 327, and October 1984 BYTE, page 33.) The Sieve column in the BASIC Performance graph shows how long it takes to run one iteration of the Sieve of Eratosthenes prime-number benchmark. The Calculations column shows how long it takes to do 10,000 multiplication and 10,000 division operations using single-precision numbers. The System Utilities graph shows how long it takes to format and to copy a standard text file to disk (adjusted time for 40K bytes of disk data) and to copy a 40K-byte file using the system utility programs. The Spreadsheet graph shows how long it takes to load and recalculate a 25- by 25-cell spreadsheet where each cell equals 1.001 times the cell to its left. Microsoft Multiplan was the spreadsheet used. The Osborne 3 used MS-DOS 2.11 and GW-BASIC. The IBM PC used PC-DOS 2.0 and BASICA. The Apple IIe used ProDOS, except for the spreadsheet test, which was done using DOS 3.3.



Photo 4: *The right side of the Osborne 3 contains the two 5¼-inch floppy-disk drives.*

ternal monitor, so only text-based programs and the text parts of integrated packages will run. In some cases, the graphics portions of programs confuse the machine; for example, loading a SuperCalc template that contains graphs crashes the system. The solution in this case is to load a partial file, large enough to contain only the spreadsheet.

While writing this review, I tried several versions of the Osborne machine, each with enhanced ROM chips and each running more IBM PC programs than the last. WordStar, Superwriter, PeachText, dBASE II, CrossTalk, Multiplan, and SuperCalc 3 worked without a hitch on the latest and, according to Osborne, final version. All O3s shipped to dealers will have the updated ROMs, and everyone who bought an earlier machine will receive the new chips, I was told.

Another potential compatibility barrier is memory size. A 256K-byte O3 has about 30K fewer bytes of usable memory than a 256K-byte IBM PC. The extra space is taken up in the memory-mapped video display, screen buffer, ROM working storage, and memory for the icon functions. This size difference can be critical for large programs such as ThinkTank, which gave me an "insufficient memory" message when I tried to run it on a 256K-byte O3. Other large programs, such as Framework and Symphony, may be restricted in file size.

Documentation

Three manuals come with the O3: a user's guide for the computer, an MS-DOS guide, and a manual for the appointment calendar.

The user's guide covers the usual description of the case and keyboard, instructions for loading MS-DOS and making copies, and highlights of MS-DOS. It also has instructions for the nonexistent modem.

The MS-DOS guide includes a short section on using the operating system with the Osborne 3. Rather than lumping DOS commands into one alphabetical list, the guide breaks them into sections on handling disks, handling files, general commands, directories, and input/output.

The manual for the appointment calendar provides instructions for entering appointments, setting alarms, changing calendar entries, and keeping archives of appointments. It has a summary of commands and a glossary of error messages.

Support

Osborne has established a network of about 175 dealers across the country who will sell and service the O3. Two people in Osborne's offices will answer questions over the phone, though there is no toll-free number. The company encourages dealers and users groups to assume much of the burden of support.

Conclusion

Osborne and Morrow have built products around a computer designed by Vadem Inc. (Santa Clara, California). Morrow licensed the technology from Vadem and has since made its own modifications. Zenith, in turn, licensed the technology from Morrow and sells a similar machine. Osborne's relationship with Vadem involves manufacturing and system support. Vadem engineers have made extensive changes to the Osborne 3, mostly improving its IBM compatibility.

The O3 has two essential attributes of a truly useful portable computer: real portability and straightforward data storage. As long as your application does not involve graphics and you can live without slots, you would probably be satisfied with the O3. Its compatibility is not complete, and your software may find a loophole that the Osborne engineers did not close. Another consideration is speed; the O3 is slower than the IBM PC in all categories. Within those limitations, however, the Osborne 3 is a solid machine that provides the necessities in a very compact package. ■

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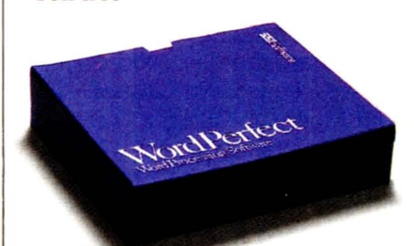
> new version lives up to its perfect billing.
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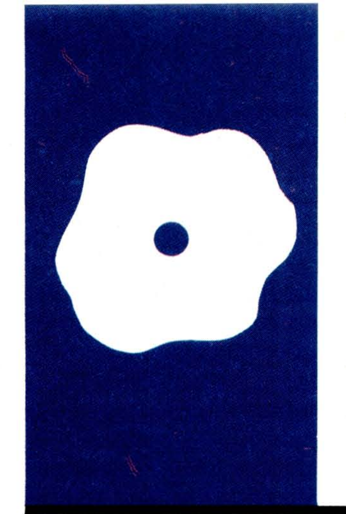
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WordStar 2000

WordStar's first offspring is easy to use but somewhat slow

BY MALCOLM C. RUBEL

Although WordStar was not the first word processor for microcomputers and some people argue that it is not the best, it is certainly the most successful. While hundreds of users wrote patches to help the program do more than it already could, the publisher of the package made few changes or improvements until now.

In response to a large number of competitors who claim that their word processors are easier to learn and use, MicroPro has released WordStar 2000 for the IBM PC and compatibles.

The new WordStar 2000 is available in the basic version and as WordStar 2000 Plus. The basic version contains MicroPro's spelling checker, CorrectStar, and retails for $495. The Plus version includes MailMerge, StarIndex, and a new feature, TelMerge. WordStar 2000 Plus retails for $595.

MicroPro has gone to considerable lengths to eliminate the difficulties that new users have encountered with WordStar. The product includes a new training guide of over 200 pages and a guide to the program's advanced features (it's 217 pages and included with WordStar 2000 Plus) giving further lessons for TelMerge, MailMerge, and StarIndex. Also included is a new series of interactive disk tutorials that will provide basic information for beginners.

WordStar 2000 is easier to learn than the original WordStar. For those with WordStar experience, the program will look familiar but the keystrokes will be different. MicroPro still uses control-key sequences to invoke commands, but these sequences have been changed to resemble the command a bit more closely. For example, Ctrl-C gives the choices for moving the cursor, Ctrl-P brings up print enhancements, and Ctrl-L is for locate. WordStar 2000 also uses Ctrl-G to call up context-sensitive help virtually anywhere in the program (Ctrl-H is the backspace code, not the help code).

MicroPro has also assigned many more commonly used commands to the function keys (shifted and unshifted) and to the number keys at the top of the keyboard combined with Alt. The assignments made by MicroPro include some infrequently used commands such as Merge: Select Data File and Merge: Next Copy, but leave out such commonly used commands as Locate and Remove Block.

MicroPro lets you change the commands on the function and number keys in its installation program, but all the reference aids that the company provides have the basic assignments etched in plastic. When you make changes, the cards become much less useful.

Those commands in WordStar that were somewhat unusual have been straightened out and are easier to remember. Dot commands and format changes are no longer necessary. WordStar 2000 contains predetermined format lists that provide all the basic setups for the user. You simply specify which one you want to use when you create your document, and that format will be used each time you work with that file. You can also create your own format files.

Most of this is great, but what's the catch? Unfortunately, WordStar 2000 executes more slowly than its predecessor and, in some instances, has become less easy to use because it's become easier to learn.

STARTING UP

WordStar 2000 requires version 2.0 or higher of MS-DOS or PC-DOS, two disk drives, and a minimum of 256K bytes of RAM (random-access read/write memory). More RAM can be assigned to buffers in the CONFIG.SYS file and speeds up execution considerably. Like WordStar, the new program makes heavy use of overlays.

The opening menu now takes up two screens; the user can toggle between them by using the space bar. WordStar's basic approach is still there but MicroPro has spread out the menu so individual entries are easier to see. You activate menu choices by

(continued)

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typing a one-key mnemonic.

To edit a document, you strike E and either type in the filename or move the cursor to it. If you are creating a new document, you are also asked which format file to use. As mentioned earlier, the format comes up with the file each time you call it, saving the initial formatting that was necessary with WordStar.

TEXT ENTRY

Once you choose the format, you are presented with the editing screen. The menu of the basic editing options takes up the top half of the screen, but you can set the program so only the submenus show after you strike the initial menu key or so that no menu shows at all.

Those familiar with WordStar will feel at home with the editing screen; it looks the same. Tabbing, which is set every *n* spaces in the format files, can be reset as you wish. Decimal tabbing is available with a choice of U.S. or European decimal points. You move the cursor either with the cursor keys or by using the traditional WordStar control-key cursor "diamond." You activate large cursor moves by using the Ctrl-C submenu of commands. The commands mirror those available with WordStar.

Unfortunately, moving through a WordStar 2000 file can be a slow process. In all comparative tests, I found a substantial reduction in performance. The most serious problem is the screen-rewrite time. It is so slow that when you hold the down-arrow key to scroll through the file, the display goes blank as you move off the current screen. You must release the key for a few seconds to let the screen rewrite. In all cases, WordStar 2000's times were slower than WordStar's, even with a hard disk.

TEXT EDITING

You can delete text using the backspace key for delete left or the delete key for delete right. I found it unusual that the delete left command is an overlay; i.e., it is not always in memory. The first time you use it, the program has to load the code for this command from drive A. That process takes more than a second. Larger deletions, such as delete word, sentence, paragraph, etc., are included in the Ctrl-R (Remove) menu. The program also has an Undo command (Ctrl-U) that makes this function a powerful cut-and-paste option.

Block operations perform smoothly. Blocks can be either horizontal for normal text or vertical for tables. WordStar 2000 has also provided for block sorting (either numerically or alphabetically in ascending or descending order) for blocks up to 150 entries and block arithmetic (horizontally and vertically).

One feature most people will like about WordStar 2000 is its dynamic justification. As you insert and delete text, the paragraph remains justified, and if you change your margins, text will automatically be reformatted to your new margin settings. However, the reformatting is not instantaneous. If you reset the margins and then try to page through your file using the PgDn key, the time it takes to write a new screen of text increases from 2.6 seconds to 6 or 7 seconds.

A second feature that will be useful to some users is the program's windowing capabilities. WordStar 2000 will open up three different windows to look at three different files. You can shift text from one file to another, making document assembly much easier. Window sizes are predetermined and cannot be changed.

Search and Replace operations are now included in a single command, Ctrl-L (for Locate). To search, you enter the string and strike several carriage returns to invoke. To replace text, you type R after entering the search string and then, when prompted, type in the replacement string. A large number of options are available, including whole-word search, case sensitivity, and wild cards. Unfortunately, the speed at which WordStar 2000 performs these operations is quite slow even with a hard-disk system. See the times in table 1.

FORMATTING AND PRINTING

WordStar 2000 provides for multiple-line headers and footers that you can alternate for right- and left-facing pages, separate print offset settings for right- and left-facing pages, flexible page-number placements, any number of different line lengths and tab settings in a document, and justified and nonjustified text included in a single file. You indicate line spacing by selecting different line heights. They allow for single, double, and triple spacing, as well as eight lines to an inch, but do not have the number of choices that were available with the WordStar Line-height command.

WordStar 2000 has improved WordStar's Hyphen-help function. The program has a function that will automatically insert hyphens where necessary as part of the dynamic justification process. Text looks better when you use the function. It works well, but I wish that MicroPro had given me the chance to define the decision criteria for applying hyphenation. The algorithm is not accessible to the user.

Table 1: *A comparison of benchmarks obtained with* WordStar 2000 *and* WordStar 3.3. *All tests were done on an* IBM PC *with* PC-DOS 2.1, *and times are in seconds.*

	WordStar 2000 (Floppy)	WordStar 2000 (Hard disk)	WordStar 3.3 (Floppy)
Load program	43.2	16.6	9.5
Load 4000-word file	14.4	11.7	9.9
Save 4000-word file	23.7	23.7	25
Move cursor down 40 lines	9.3	9.3	4.4
Go to end of file	73.1	67.3	9.9
Search	130	117	11
Replace string 400 times	217	204	34.7

AT A GLANCE

Name
WordStar 2000 and WordStar 2000 Plus

Type
Word processor

Manufacturer
MicroPro International
33 San Pablo Ave.
San Rafael, CA 94903
(415) 499-1200

Format
5¼-inch MS-DOS, six disks supplied, copy-protected

Computer
IBM PC and compatibles, 256K bytes of RAM

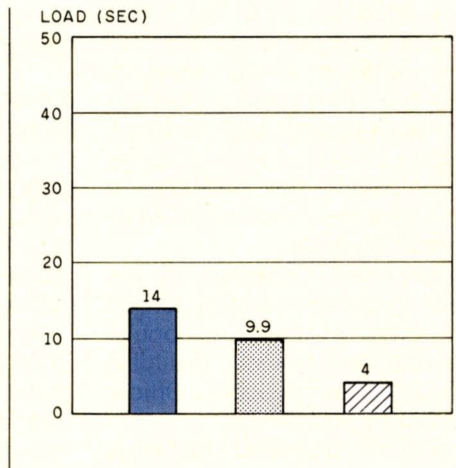
Necessary Software
MS-DOS or PC-DOS version 2.0 or higher

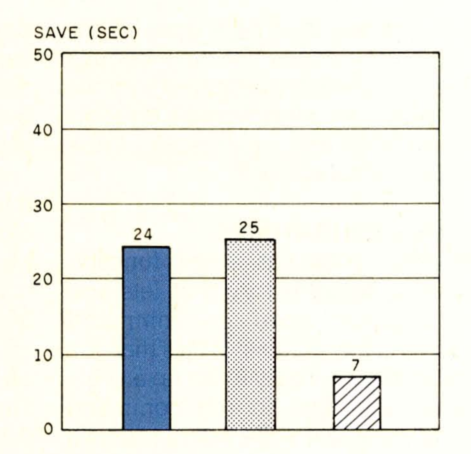
Documentation
Four manuals (five with WordStar 2000 Plus) covering installation, tutorials, reference, and advanced features

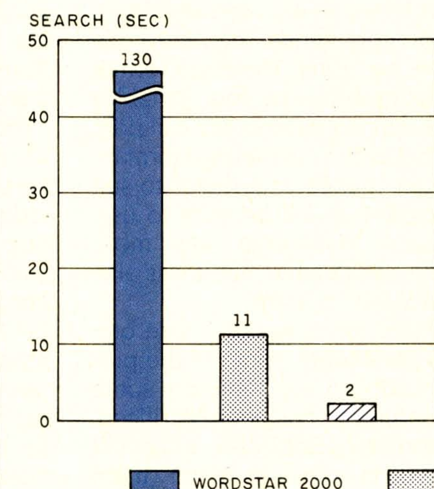
Price

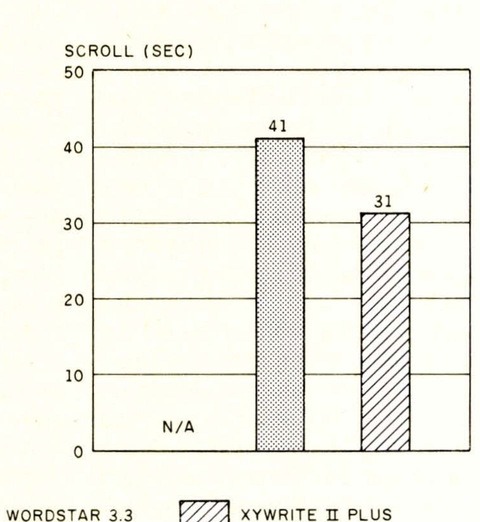
WordStar 2000	$495
WordStar 2000 Plus	$595

Comments
WordStar 2000 is a full-function word processor that provides distinct improvements over WordStar. It is easier to learn and, in some respects, easier to use. However, the program is very large and slower than its predecessor.









WORDSTAR 2000 | WORDSTAR 3.3 | XYWRITE II PLUS

A comparison of WordStar 2000 with WordStar 3.3 and XyWrite II Plus. The graphs show the results of performing various standard word-processing functions using a 4000-word text file. The Load graph shows the time required to load a file from disk to memory. The Save graph shows the time required to save the file on disk. The Search graph shows the timing results for a search starting at the beginning of a file and looking for its last word. The Scroll graph illustrates the time required to scroll manually from the first line of the file to the last line. The manual scroll results for WordStar 2000 are not shown because the program uses a screen rewrite function instead of line-by-line scrolling.

WordStar 2000 supports everything from typewriter conversions to the HP LaserJet. It prints proportionally if the feature is supported on your printer, but instead of adding microspaces between the characters when performing right justification on my test printer (NEC 3550), it added microspaces between the words. Intercharacter microspacing gives a finished document a better look.

WordStar 2000 supports chain and nested printing but, unlike WordStar 3.3, does not do background printing. WordStar 2000 has a function called Print and Resume Editing that prints a copy of the file to disk and then goes back to the opening menu. With a file of any size, the time you spend waiting is considerable. BYTE's 4000-word benchmark test file took 199 seconds to format on a floppy system and 168 seconds on a hard-disk system before bringing me back to the opening menu. You must also make sure you have enough space on your logged disk drive to accommodate the temporary print files because they take up more space

(continued)

than the document file does. If the logged drive does not have enough space, you will be presented with the message: "An unrecoverable error occurred while printing (filespec). Press ESCape to continue."

ADVANCED FEATURES

WordStar 2000 has a new function called a key directory that lets you store either word or command macros in any number of files that you desire. They are easy to set up and execute. You type in the command string under which the macro is stored and press Esc, and the macro will be executed. For repetitive procedures, this is a godsend.

The basic version of WordStar 2000 comes with CorrectStar, MicroPro's spelling checker. The program seemed to work well. You can create personal dictionaries to supplement the basic dictionary. This program is also slow, taking 305 seconds to make a single pass with no corrections through a 5000-word test file on the floppy system. When making corrections, CorrectStar ran even slower, requiring 17 to 30 seconds to read through 1 to 17 lines of text and highlight a mistake. Performance on a hard disk was not much better, although you do avoid changing disks. Unfortunately WordStar 2000, like earlier versions of WordStar, changes bit 8 of the last character in each word, so many of the other spelling checkers will not work directly with its files.

WordStar 2000 Plus includes something completely new, TelMerge. It also includes new versions of MailMerge and StarIndex.

With a modem, TelMerge lets you use your computer as a terminal and call up several of the more popular on-line database systems, including The Source, CompuServe, Official Airline Guide, and others.

MicroPro has simplified MailMerge and put it into an easy-to-use format. The dot commands and bare file structure are gone. The entry format is predefined but has four variables for user-defined entries. You can print labels, but only in predefined formats. If you can change your needs to suit the program, it will be easy to use. WordStar's MailMerge was more powerful and flexible, but it was also more difficult to learn.

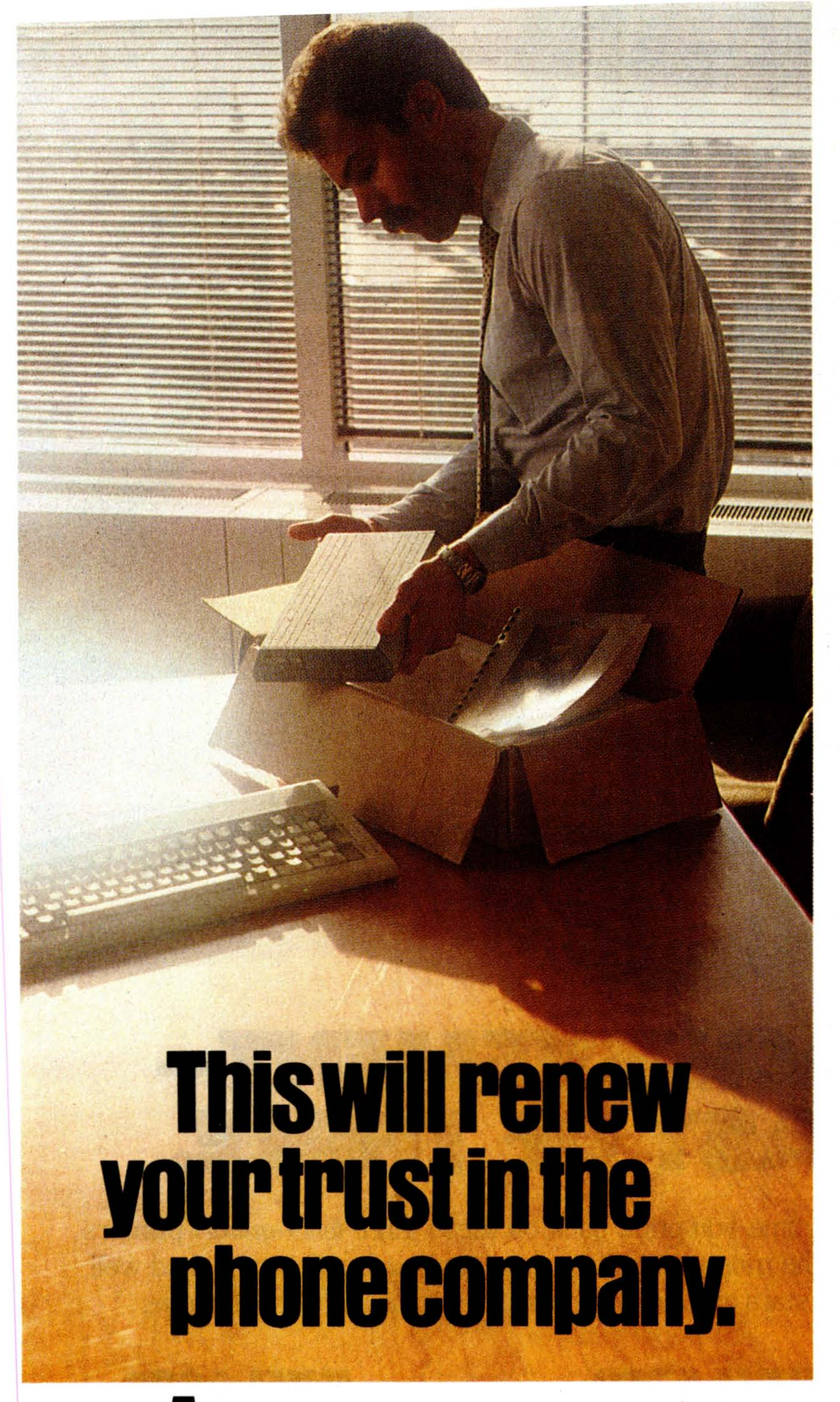
StarIndex too is easier to use but, as with MailMerge, some of the program's flexibility, and therefore some of its usefulness, has been sacrificed. With WordStar's StarIndex, you could either type in entries or identify them in the text being indexed. StarIndex for WordStar 2000 requires that you type in each index entry.

CONCLUSIONS

People who are familiar with WordStar will find the transition to WordStar 2000 easy; its approach to word processing is similar to its predecessor's. For new users, the excellent tutorials supplied with the program make a big difference in how easy it is to learn.

There is not much that WordStar 2000 cannot do well. The problem is that it will do it slowly and sometimes with more intervention from prompts and confirmations than I would like. WordStar 2000 is written in C, which lets MicroPro transport it easily to other machines, but this results in slower program execution.

The program is so big that, like WordStar, it must continually access the program disks to overlay program code. With the original WordStar running in a 64K-byte environment, this problem was understandable. WordStar 2000, however, was designed in the 16-bit world. Its minimum memory requirement of 256K bytes should have improved this disk-access problem for program code and working file, but it has not. The program runs more slowly. If time is money, WordStar 2000 is an expensive program. ■



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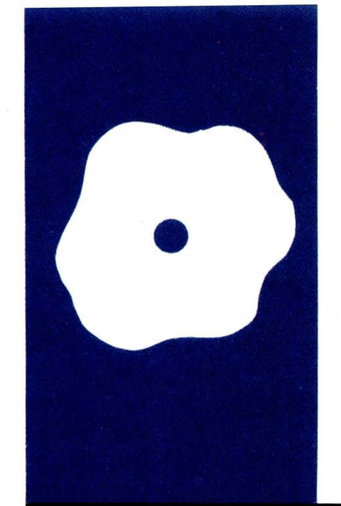
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XyWrite II Plus

Word processing from the command line

BY RUBIN RABINOVITZ

XyQuest Inc.'s XyWrite II Plus is an innovative word-processing program for the IBM Personal Computer (PC) and compatibles. An advanced version of the entry-level XyWrite II, XyWrite II Plus is powerful and reasonably priced ($295), and it has many attractive features. While XyWrite (pronounced *zye-write*) can run on computers with 128K bytes, it needs more memory if you plan to work on documents longer than, say, 30 to 40 pages. The program will make use of any extra memory beyond the minimum 128K bytes, up to 640K bytes.

XyWrite executes commands very quickly. The screen display can provide comprehensive format information or a version of your text that's close to the printed output. XyWrite also has some interesting advanced features, such as a redefinable keyboard, sophisticated macro routines, easy access to DOS (disk operating system) or another program, programming capability, and a facility for reconfiguring printer files.

The authors of XyWrite helped design Atex, a large multiterminal text-processing system with editing and typesetting capabilities. (Atex is used mainly by large firms—publishers, insurance companies, and law offices—that routinely print a great number of documents.) The two systems are in many ways similar, a factor that should make XyWrite especially attractive to Atex users.

THE COMMAND LINE

The most distinctive characteristic of XyWrite is its reliance on a command line for initiating major operations. Let's say you've finished editing a file and want to save it. You move the cursor to a line reserved for entering commands at the top of the screen, type the command word for saving a file, and then press Return. Displaying another file or creating a new file involves different command words, but the rest of the procedure remains the same. Some XyWrite routines are initiated by the IBM PC's function keys (F1 through F10), but where other programs typically offer menus or screen prompts, XyWrite makes use of the command line.

Most of XyWrite's commands have logical names, which helps when you're learning the program. For example, STORE lets you save a file, CALL displays an existing file, and NEW creates a file. Once you've learned the program you can save time by using abbreviations of these commands. In most cases, entering the first two letters of a XyWrite command word has the same effect as spelling it out; either ST or STORE is a legitimate command for saving a file.

XyWrite has more than a hundred commands of this sort. While this leads to flexibility in some of the program's advanced routines, it also introduces difficulties. Learning a great number of two-letter commands—as WordStar users know—can be time-consuming. Forgotten command words lead to annoying interruptions because you have to consult the manual. Typing mistakes force you to back up to revise the command entry. Such factors make working with a command line more demanding than choosing from options listed on the screen. If your favorite programs use menus extensively, you may not like this aspect of XyWrite.

A related problem has to do with the number of keystrokes required to complete command operations. In XyWrite the minimum number is usually four: one keystroke to move into the command line, two to enter the abbreviated form of the command, and one to execute the command. Comparable operations in other programs often involve fewer keystrokes.

However, once you've entered the commands they are executed very quickly; operations such as deletions, changes of format, and cursor movements occur almost instantaneously (see table 1). Such speed is possible because the program keeps your file in RAM (random-access read/write memory) until you decide to

(continued)

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write it onto the disk. This, of course, makes your data vulnerable to loss in case of a power outage or a forgotten update command. But storing data is simple, and XyWrite has a trick that lets you keep updating your file easily. As long as you don't need the command line for another purpose, you can let the STORE command remain there; then, with one keystroke you can update your file. This principle applies to other XyWrite operations: Whatever you've entered in the command line remains there until you replace it, so you can easily keep repeating commands.

LEARNING THE PROGRAM

One flaw in a number of good programs is instructional material that looks as if it were written by someone whose native tongue is hexadecimal. While XyWrite's documentation isn't the worst I've ever seen, clarity is not its strong suit.

Some sections of the XyWrite online tutorial flash by too quickly, while others merely repeat material that appears in the printed version. The manual's instructions are often incomplete, and at times it uses new names for familiar items (for example, the Backspace key is called the Rubout key). Another shortcoming is the manual's lack of illustrations and the absence of a printed keyboard chart (the only key-definition chart is on a help screen).

GET THE UPDATE

When I first began working with the program I discovered some errors in the manual, including misspelled command listings; I had been assuming that some mistake of mine was holding me up. I spoke about this with John Hild, one of the authors of XyWrite; he assured me that a new version of the program contained corrections. I duly tested this new version and found that the errors had been eliminated. In addition, although the texts of the original tutorial and manual have been retained, XyQuest has added a new tutorial booklet for beginners, entitled *XyWrite Level I Tutorial*. This booklet is clearly written and, unlike the manual, has easy directions for installing the program.

If you're planning to buy XyWrite, be sure you're getting the updated program, which isn't as easy as it sounds—the earlier release and the update are both labeled version 1.00 on the opening screen and version 1.20 on the help screen, and neither designation appears on the manual's slipcase. In the newer version, however, the copyright year on the disk label is 1984 (versus 1983), and the aforementioned tutorial booklet is included with the program. If you bought the earlier version of the program and would like to have this booklet, XyQuest will sell you a copy for $10.

HELP FACILITIES

XyWrite has only four help screens: one with general information, one with a keyboard chart, and two with listings for the major commands. The help screens are fairly elementary; displaying them is cumbersome. The help information fills the entire screen, so you can't see your file. Unlike many programs, XyWrite doesn't give you a specific message when you need to correct an error or complete a command sequence. Some commands are missing from the on-screen keyboard chart: XyQuest seems to have used the same help screens for XyWrite II Plus as it used for the entry-level version of the program.

You can create your own help screens, but this hardly makes up for the skimpiness of the ones provided. Asking users to write their own help screens seems a bit odd, something like telling a drowning man where he can get swimming lessons.

CURSOR AND FUNCTION KEYS

In general, XyWrite follows the IBM keyboard definitions; for complex cursor movements you use the cursor keys in combination with Ctrl and Alt. XyWrite doesn't provide as much cursor control as some other programs; you can't advance the cursor by sentence or paragraph or move from the middle of a line to the beginning of the next one with one keystroke. At the same time, three keys on the cur-

(continued)

Table 1: *Benchmark results using XyWrite II Plus on the IBM PC (with 640K bytes and an adapter for a monochrome monitor) running a standard 4000-word document.*

Test	Time (seconds)
Begin Program: time to load the XyWrite Editor program from the DOS A> prompt	4
Save Document: time to store the standard file on the disk	7
Recall Document: time to retrieve standard file from disk and display on screen	3.69
Search: time to find the last word (the 4000th) of the standard file	2
Scroll: time to scroll from the beginning to the end of the standard file	31
End of File: time to go to the end of the file and reset the page and line counter by pushing Ctrl-End	2.38
Delete: time to delete the first 5 words of a 100-word paragraph and reformat	immediate
Insert: time to restore the 5 deleted words and reformat	immediate
Format Changes: time to change spacing, margins, lines per page, margins, and pitch	immediate
Print File: time from entering the command to print a file to the start of printing	2.52

AT A GLANCE

Name
XyWrite II Plus

Type
Word-processing package

Manufacturer
XyQuest Inc.
POB 372
Bedford, MA 01730
(617) 275-4439

Computer
IBM PC, PC XT, PCjr, and compatibles with one disk drive and at least 128K memory; TI Professional, Hyperion, and DEC Rainbow

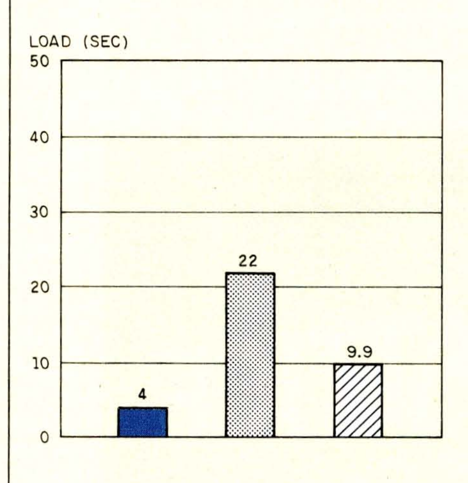
Format
One 5¼-inch double-sided floppy disk

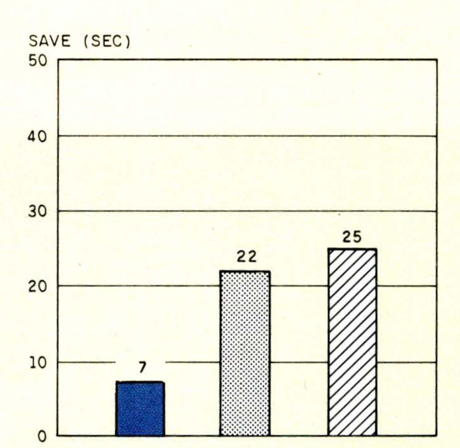
Language
Assembly

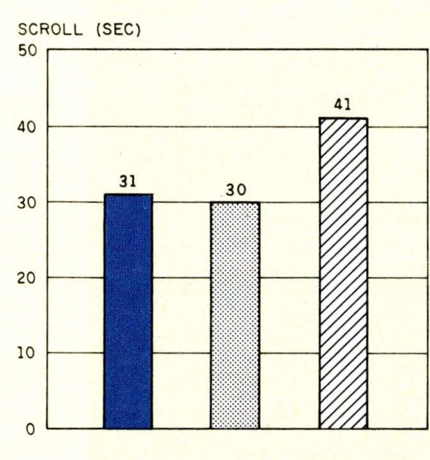
Documentation
634-page indexed manual; 71-page indexed beginner's manual

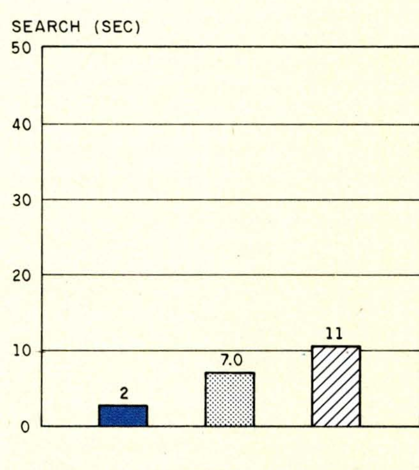
Price
IBM version, $295 plus $5 shipping
TI and Hyperion versions, $325 plus $5
DEC version, $350 plus $5
demonstration disk, $7

Audience
Experienced users who want an advanced word-processing program









XYWRITE II PLUS VOLKSWRITER DELUXE WORDSTAR 3.3

A comparison of three word-processing programs—XyWrite II Plus, Volkswriter Deluxe, and WordStar 3.3. The graphs show the results of performing various functions using a 4000-word text file. The Load graph shows the time required to load the file from disk to memory. The Save graph shows how long it takes to save the file to disk. The Scroll graph shows the time required to scroll through the file manually. The Search graph shows the time it takes to find the last word in the file, starting at the beginning.

sor pad (5, +, and −) aren't used for cursor movements. This is an inefficient arrangement. However, it seems from the reserved function calls listed in the manual that XyQuest may add some new cursor commands to future releases of XyWrite.

Normally, XyWrite operates in Insert mode. But the program also has an Overstrike mode. You use the Insert key to toggle back and forth between modes, and the cursor changes from a box to a line to indicate that you've gone from Insert to Overstrike.

XyWrite's definition of the function keys is somewhat unconventional. While some keys have many functions, others are redundant; for example, you can use either F5 or F6 to move the cursor to the command line. Given the frequent use of the command line, the authors of the program must have felt that this operation should be duplicated. But I didn't find this helpful; I always used F6 and never bothered with F5. In the same way, either F9 or the Return key can be used to execute commands.

XyWrite uses many of the other function keys for its Define procedure, which involves highlighting a block of text prior to performing some operation on it. Moving, copying, and deleting blocks are done entirely with the function keys, which means you don't have to go into the command line to perform these operations.

Assigning four operations to some function keys and only one to others makes it hard to remember some function definitions. Even so, being able to redefine the keyboard means that you can remedy such problems.

Display

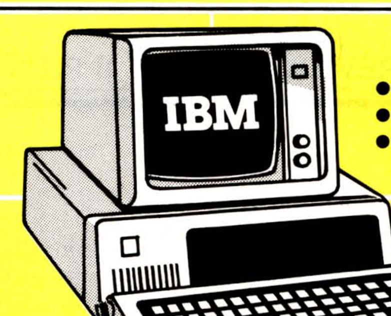
XyWrite reserves three lines on the screen for program information. At the very top is the command line. Next is the prompt line; it contains information about modes of operation, such as the status of the Caps Lock and Num Lock keys. For the third line you have some choices: You can display a ruler with margin and tab information, a summary of the function key commands, or a straight line. The rest of the screen is reserved for your document.

XyWrite has three viewing modes, which permits you to look at text with or without control characters. Page Review mode shows you what the printed document will look like. Expanded Input mode displays all of the control-character information; this is the mode you'd use to make extensive format changes. Perhaps the most useful is the Formatted mode, a compromise between the other modes. In Formatted mode you see a bright triangle at each location where format information has been embedded. When you move the cursor under one of these triangles, the

(continued)



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Word-processing programs seldom let you change their standard routines. XyWrite II Plus is an exception. You can easily enter the command words in executable files.

relevant format information is given in the prompt line. This is a clever idea; the triangular markers take up very little space, yet the information they contain is readily available.

MAJOR FEATURES

XyWrite has many of the features found in sophisticated word-processing programs. These include search and replace, with uppercase and lowercase sensitivity, wild cards, and forward or backward search (because the working document is kept in RAM, search and replace routines are very fast); microjustification, which lets you adjust the spacing between letters; special character display, including boldface and reverse video; automatic footnotes, printed at either the bottom of a page or the end of a document; mail merge, including the capability to transfer a list created in another program (a database manager, for example) into XyWrite; two user-defined windows, either vertical or horizontal, and a whole-screen window that lets you toggle between pages from different files; extended ASCII (American Standard Code for Information Interchange) character sets, including foreign characters and scientific symbols; special keyboard layouts, either user-defined, Dvorak, or Spanish/Portuguese (included on the program disk, although there's nothing in the manual about these keyboard files); 18 printer command files that support some 30 printers (if your printer isn't supported, you can create your own command file or send your printer manual and program disk to XyQuest and the company will write one for you); book-editing functions, including tables of contents and indexes, arranged alphabetically or in page order; and a math feature that lets you calculate and insert the results into text.

Though it can generate "soft hyphens" (hyphens that disappear when revisions make them unnecessary), XyWrite does not have an automatic hyphenation utility. XyQuest says it will include this feature in an update of XyWrite II Plus, to be released sometime this year.

The program also lacks a spelling checker, but since its files are written in ASCII, many of the spelling programs currently on the market are compatible with XyWrite. XyQuest recommends The Word Plus Spelling Checker (Oasis Systems) and Word Proof (IBM).

PROGRAMMING FEATURES

Word-processing programs, unlike many database-management packages, seldom give you opportunities to change their standard routines. XyWrite II Plus is an exception. Its use of a command line contributes to XyWrite's programming capability, since you can easily enter the command words in executable files.

The advanced features are not for novices; using them takes a certain amount of experience. Still, only a few routines require a knowledge of programming, and if you don't mind reading the manual and experimenting, you'll appreciate what you can accomplish with these utilities.

The save-and-get function, for example, lets you store a block of text (like a long book title or a boilerplate paragraph) and then insert it into the text by pressing Alt and an alphanumeric key. If you create a number of these save-and-get blocks, XyWrite can display a directory to remind you of their contents.

Another advanced feature permits you to remap the keyboard. For example, if you own an IBM keyboard and are irritated by the placement of the Backslash key, you can transform it into a Shift key. You can also redefine keys so they perform command functions. These can be simple operations or fairly complex ones, where a short key sequence executes a file with many XyWrite letter commands. If you've used key-defining programs like ProKey, you'll be familiar with this routine. XyWrite also has a more complex macro function that lets you create executable files made up of a series of commands together with any data you may wish to enter.

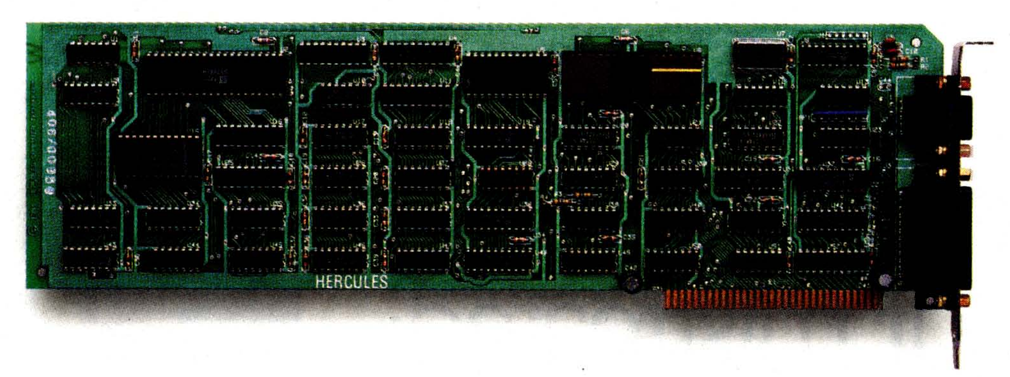
XyWrite lets you use GoTo commands, variables, and command expressions like "if" and "greater than" in executable files. This adds up to real programming capability: You can create routines that the off-the-shelf version of XyWrite isn't capable of performing.

Finally, XyWrite lets you go into DOS without removing XyWrite from machine memory. You can perform functions in DOS and then return to the document you're editing—with the cursor in the same position as it was before you entered DOS. If your system has enough memory, you can even run another program (such as a spreadsheet or a database manager) together with XyWrite and move back and forth between them.

CONCLUSIONS

Some portions of XyWrite are very impressive; others need to be improved. Experienced PC users who can make use of its advanced capabilities, especially its programming features, will doubtless become XyWrite fans. Other people may be better off with a word-processing package that provides more user amenities.

In the world of word processors, XyWrite is like a sports car. It's fast; but the ride can be a bit rough, and to get it going properly you may have to do some tinkering. If you're not sure whether this much sportiness is for you, I recommend a trial spin with the XyWrite demonstration disk. ■



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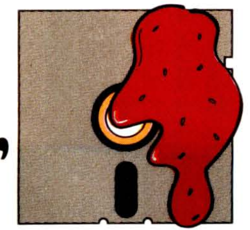
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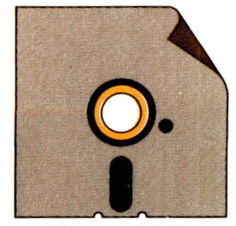
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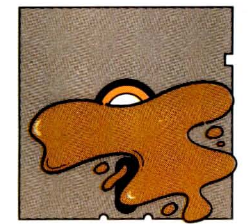
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Address: 2550 Ninth St., Berkeley, CA 94710 Ph: 415 540-6000 Telex: 754063. **Trademarks/Owners:** Hercules, Graph X/Hercules; 1-2-3, Symphony/Lotus; IBM, XT, AT/IBM; Framework/Ashton-Tate; SuperCalc/Sorcim-IUS; Microsoft/Microsoft; pfs:/Software Publ; AutoCAD/AutoDesk.

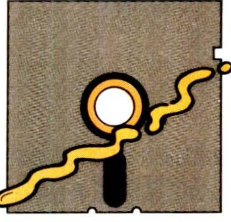
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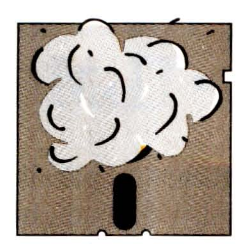

Aunt Molly's jam

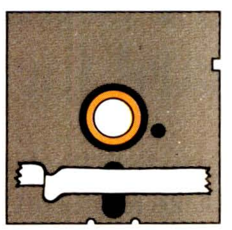

Dog-eared jacket

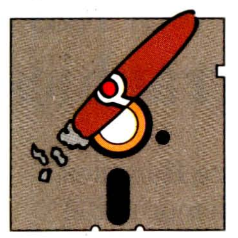

Regular coffee, two lumps

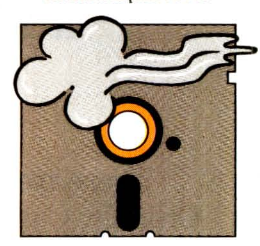

Maria's liquid cover

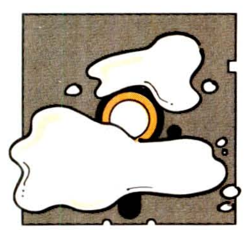

Hot dog mustard

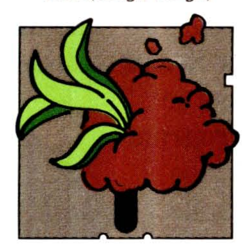

Dust (cough-cough)

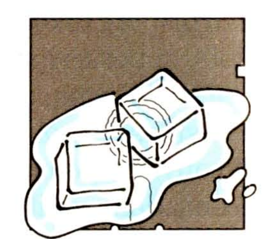

Tacky white tape

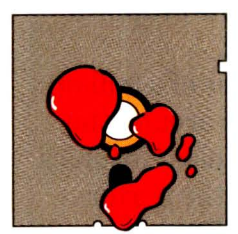

Boss's cigar ashes

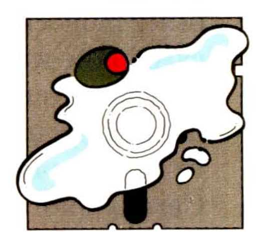

Clouds of smoke

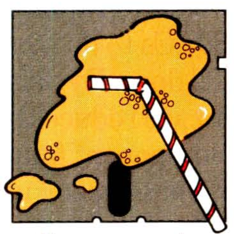

Spilled milk

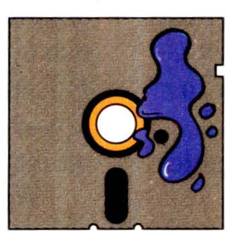

Potted plant–no pot

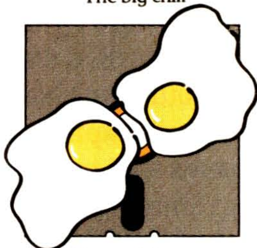

The big chill

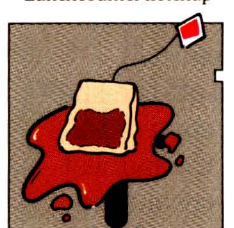

Lunchcounter ketchup

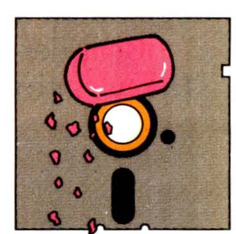

Dry martini, one olive

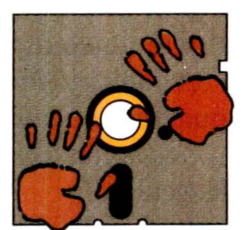

Fizzy orange soda


Waterbased ink spots


Sunny side up

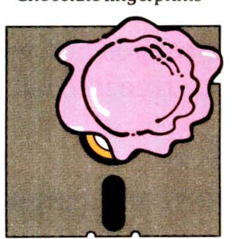

English breakfast tea


Eraser bits


Chocolate fingerprints




Sudsy soap bubbles


One scoop of ice cream



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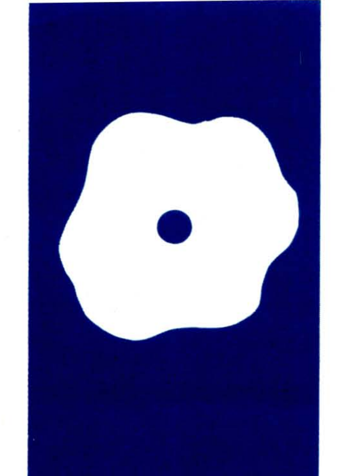
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Filevision

A graphic example of data management on the Macintosh

BY SCOTT L. NORMAN

Telos Software's Filevision attempts to apply the Macintosh's novel features—the desktop metaphor, pull-down menus, and icons—to a common task: database management. Although limited in file size and reporting capability, Filevision might be the harbinger of a new generation of visually oriented software.

With Filevision you draw a picture, map, diagram, or other graphic image, then build a series of data files associated with various elements of the image. You can sort files and select items much as with conventional text-only database managers. You can highlight items meeting the current selection criteria on the pictorial display.

Filevision is not just another database manager with graphics tacked on as a gimmick. The program's authors take the viewpoint that the text-and-number files should support and elaborate on the picture rather than the reverse. As such, the program is unlikely to be a general-purpose data handler. I would not choose Filevision for managing a mailing list, and it would not do for keeping track of General Motors' parts inventory.

DATA ORGANIZATION

The concept of a "type," or distinct class of object, is crucial to Filevision's method for organizing information. Every item in a Filevision drawing belongs to one type or another; even the background is assigned to the default type, called Background, when you begin to draw. You can design a different form, or "information record," on which you enter the data for each type, and you can specify "links," which are connections between an object in one drawing and an entirely different drawing file. Linked files are the key to storing multiple levels of detail, and you can use them to give visual expression to different ways of organizing information about a set of objects.

In Filevision, a field has essentially the same meaning as in more traditional database software: an individual piece of information about a given object. With Filevision, you can add fields to or delete them from a form at any time.

Filevision has overlapping specifications for capacity. The manual indicates that a file can contain up to 999 objects that belong to as many as 16 different types. You can use up to 30 data fields to describe each type, and the limit on the text associated with a single object is 2000 characters. A 128K-byte Macintosh will not be able to reach all the limits that should be simultaneously attainable. A Telos customer-service representative told me that small-memory machines might run out of storage at 200 to 400 objects. This depends on the complexity of the file structure and arises from the fact that pointers to various objects are maintained in RAM (random-access read/write memory) where they consume storage space. Macintoshes with 512K bytes of RAM have no difficulty reaching the published limits. The vendor should have clarified this point.

SETTING UP AN APPLICATION

The best way to get a feeling for the data-management problems Filevision can address is to work through an example. I set up a small group of files for this review: maps of the orbits of planets and some major asteroids in our solar system, supported by data sheets containing elementary facts and figures about the bodies. This application serves as a modest model for applying Filevision to teaching and also demonstrates how some of its features come into play as a result of graphics considerations.

Filevision is quite flexible concerning the order in which you perform the operations necessary to set up a database. One sensible approach is to specify the types of objects that will make up a file, define a data form for each, and then draw the objects and fill in the forms. Thus, a little pencil-and-paper planning is appropriate before ap-

(continued)

Scott L. Norman (8 Doris Rd., Framingham, MA 01701) is manager of the Solid State Science Department for GTE Laboratories.

AT A GLANCE

Name
Filevision

Type
Pictorially oriented database manager

Manufacturer
Telos Software Products
3420 Ocean Park Blvd.
Santa Monica, CA 90405
(800) 554-2496;
in California, (800) 368-3813

Computer
Apple Macintosh

Minimum Hardware
128K bytes of RAM, one disk drive

Format
3½-inch floppy disk; working copies can be made, but original disk must be used for verification whenever a file is opened from the Finder

Documentation
154-page manual with glossary and illustrated guide to all menus and commands; tutorial file on program disk

Price
$195 (backup master disk costs an additional $15)

Audience
Anyone who wants to keep track of data that can be conveniently expressed as parts of a drawing

Comments
Filevision is an innovative approach to the management of facts and figures that adheres to conventions of the Macintosh user interface; it includes its own drawing program, which is less flexible than MacPaint, and its report-generation facilities are limited

proaching the keyboard, which is as true of Filevision as it is of any database manager.

This might make it seem as though the data forms have precedence over the imagery, and that need not be the case. You can draw a complete picture and then define object types and their associated data forms; you can readily change an object's type as you go along. Form layout is quick and painless and uses typical Macintosh click-and-drag operations to set the size and position of data fields.

You do not need to identify the type of information data fields will contain: string, integer, real number, and so on. This simplifies the process of setting up a form, although it ultimately restricts the program's ability to select objects from a file.

For my example, I drew a few background elements on the screen, defined data forms for the major types of objects, drew the objects themselves, and entered the relevant data. My view of our astronomical neighborhood is shown in figure 1. I bundled the four inner and five outer planets into two members of a data type I called Planet_type. At this level, I lumped all the asteroids into one type.

The three initial data forms—inner planets, outer planets, and asteroids—were quite skimpy. However, each was linked to another drawing, and the latter was backed up by considerably more detail: one record sheet for each planet and one for each major asteroid as in figure 2.

Why didn't I just define a nine-member data type called Planets and a six-member type called Asteroids and designate them as separate elements of one drawing? In best Filevision style, I made my choice based on graphics considerations. It is impractical to show all interplanetary distances to the same scale on one drawing: the solar system is too large. By using three subfiles, I could depict groups of orbit paths in something approaching true scale—although I

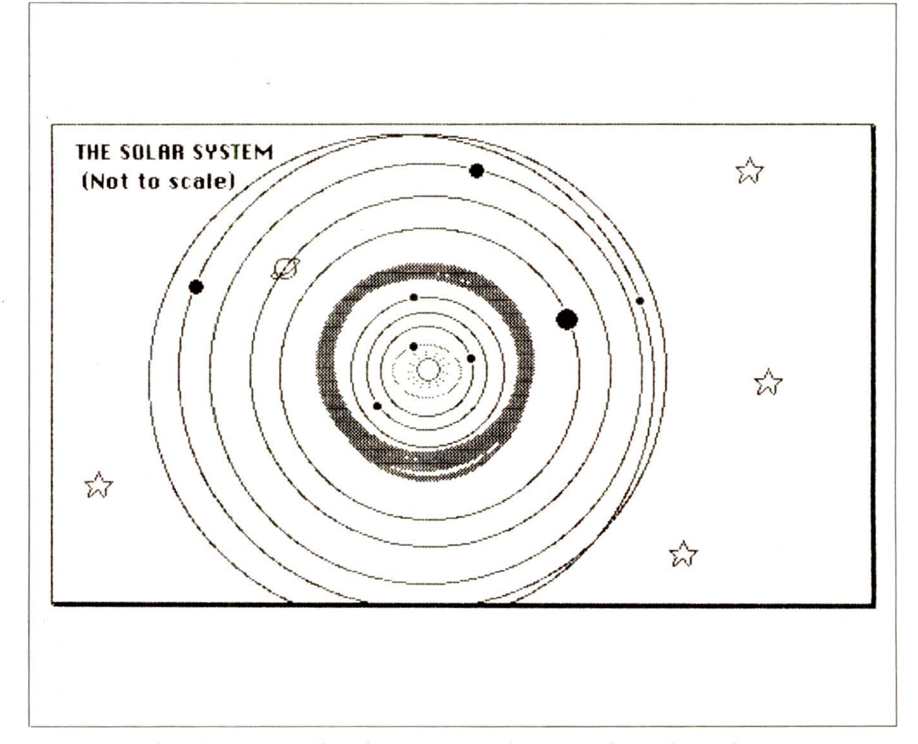


Figure 1: *The solar system file. The four inner planets are lumped together as one member of the data type Planet_type. The five outer planets constitute the other member, and the asteroids (symbolized by the broad gray band) form a second data type.*

had to cheat on the sizes of the planets themselves.

DRAWING WITH FILEVISION

Filevision's drawing screen (see figure 3) bears a family resemblance to that of MacPaint, but there are important differences between the two. The kit of drawing tools is stripped down, as is the palette of fill-in patterns hidden under the Shades menu. Filevision doesn't have an eraser or Goodies menu, and hence no Fat Bits feature for touching up the fine points. However, Filevision gives you a selection of 20 preset symbols to use in a drawing (such as the little symbol of a man in figure 3), and you can edit these in a manner somewhat like MacPaint. You can delete items from this file and replace them with others of your own design.

You can also use pictures (or "glyphs") from some of the Mac's decorative fonts. The stars, sun, and ringed planet in figure 1 all came from the Cairo character set, and I entered them with the Text tool (the A).

Filevision has one drawing tool that I would like to see in MacPaint: a Reshape command that lets you add "handles" to any figure created freehand or from straight line segments. You can use the handles to stretch the figure into a new shape; in figure 3, I used them to pull a freehand arc into a reasonable orbit for Jupiter. This figure also shows the optional grid used for alignment and scale setting. Note the typical distortion of video circles into ellipses caused by printing the screen with command-Shift-4. The distortion is rectified when you use Filevision's Print Display command to produce hard copy of an image.

Filevision normally treats every element added to a drawing as another example of whichever data type is active at the moment. For example, Filevision considers a planetary orbit and the corresponding symbol as two planets, unless you instruct the program that they represent the same object. In this case, you can use a special Bind command to link ele-

(continued)

File Edit Types Tinker Text Symbols Lines Shades
Information for this Inner Planet:
Name Mars
Link Solar System
of Satellites 2
Semimajor Axis 1.524 A.U.
Period, yrs. 1.881
Eccentricity 0.093
Obliquity, deg. 25.0
Diameter, km 6788
Mass, g 6.44 (26)
Mean density 3.9
Albedo 0.15
Cancel Prev Next Done

Figure 2: A *full screen showing the data form for the* Inner Planets *data file. Note the* Link *box, which relates this file back to the* Solar System *file.*

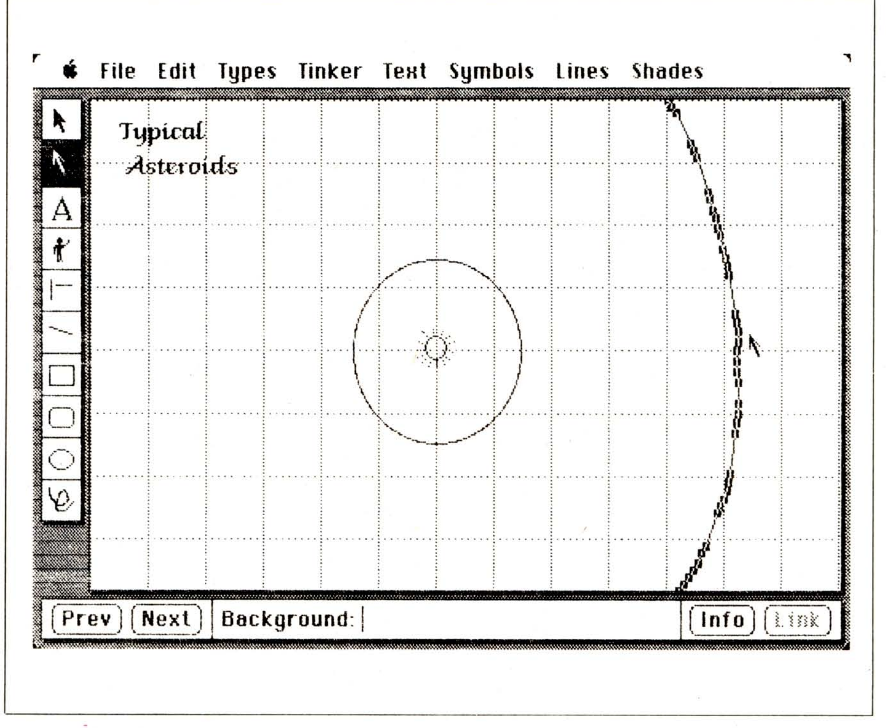


Figure 3: *The* Asteroids *drawing taking shape on the Filevision screen. Mars's orbit and the sun have been entered, and a portion of Jupiter's orbit is being pulled into shape with the Reshape tool. Note the drawing tools, which will look familiar to MacPaint users.*

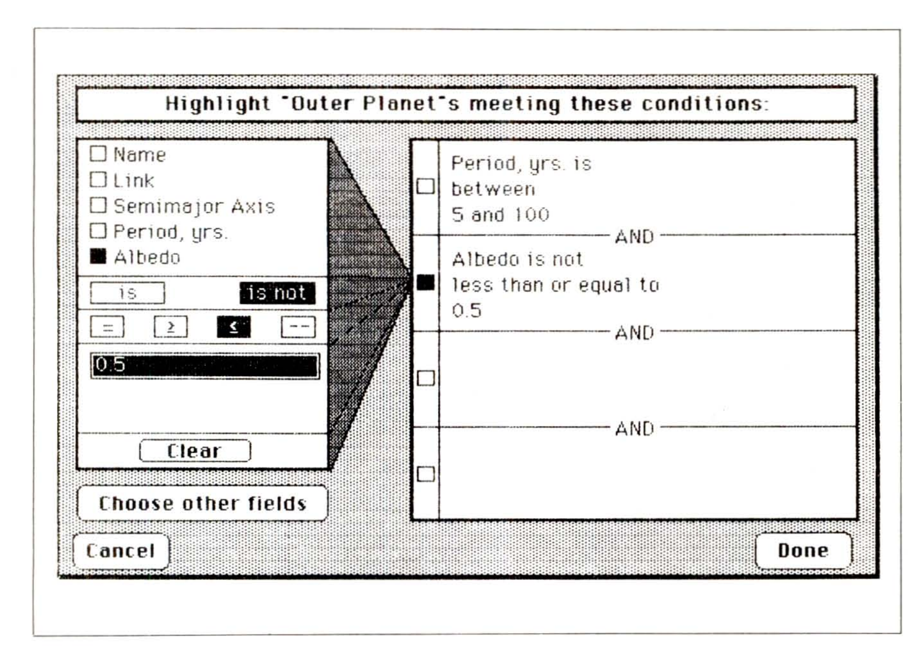


Figure 4: *Selecting fields and relationships for a Filevision report involves the point-and-click technique. You only need to type in numerical or text values for the comparisons. Objects meeting the two criteria shown here will be highlighted when the Done box is clicked.*

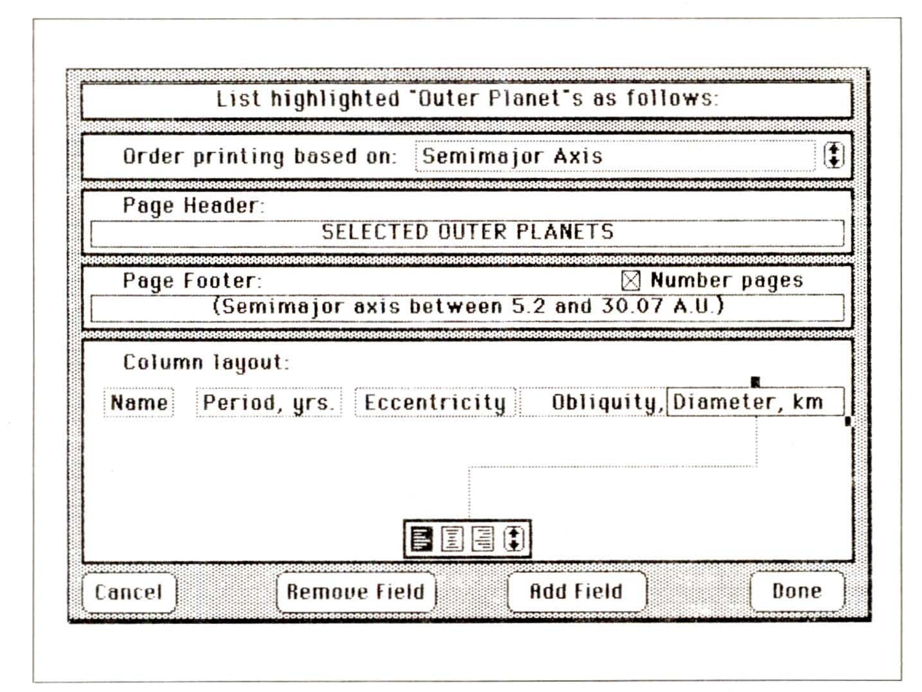


Figure 5: *The screen form used to design a Filevision List report. You use the Arrow box at the right of the "Order printing . . ." line to cycle through data fields until you find the one you want to use for organizing the report. A similar control appears at the bottom of the "Column layout" area, along with selectors for justifying entries in each column. You use the black squares on the Diameter box to stretch and pull that column into the desired position.*

ments into a compound object so you can treat them logically.

File Handling and Reporting

It is simple to reorder a Filevision file, select a portion of it, and set up a report. You pay a price for this simplicity: Reports lack many features that users of more advanced database managers have come to expect.

You can select a single object by clicking on it in typical Macintosh fashion, but Filevision's Tinker menu must handle selecting groups of objects. Objects meeting the selection criteria can be highlighted on the screen; alternatively, either the selects or the rejects can be hidden from view. Selection operations only affect the object type that the Types menu currently specifies.

You set up selections on the special screen shown in figure 4 by using the point-and-click method. You can combine up to four criteria with the logical AND operation and specify a complete range of equality and inequality conditions (the special "--" symbol denotes the condition "between"). You cannot link conditions by OR.

A Filevision selection always compares a field's contents to a fixed numerical value or to a specified character string. Filevision allows wild-card characters. You cannot compare one field to another, which is probably a result of the program using untyped data fields; without this restriction, you might inadvertently try to compare a numerical field to text.

In addition to printing the screen, you can design three types of reports—Info, List, and Labels—on video worksheets and then print them; Filevision doesn't have a facility for routing a complete report to the screen. You can place objects selected for a report in ascending order according to the contents of any field.

A Print Info command produces hard copy of all the data for each object. Filevision positions all fields as they were on the original data form, but the absence of field titles might hamper interpreting the information. This is an informal report and the quickest way to get a record of every-

thing in a file. You can add page headers and footers.

A conventional columnar report is called a List in Filevision parlance. Although the Mac's click-and-drag technology makes report layout easy (see figure 5 for a sample screen), I wish the List option were more potent. For example, you cannot find the total of a numerical column, and multilevel sorts are out. It is also difficult to judge how much room you are allocating to a given column. You reserve space for a field by stretching a text box, and Filevision has no simple way to determine its width in characters until you release the mouse button and see how the title fits. Page space can become critical, since List reports devote only a single line to each object. The maximum width allotted to a printed List is 6½ inches.

The third kind of report, a Label, lets you print as many data fields as will fit into a space 5 inches wide and 2 inches high. This time, scales appear on the layout screen. Since this is the option you would choose if you were doing mailing labels, field titles are not printed.

It's good that Filevision makes setting up a report easy, because you cannot predefine several formats and save them under their own names. Although the manual makes no mention of the fact, Filevision saves your last Info, List, and Label formats when you quit the program, so people with modest reporting requirements might have no trouble. However, any selection criteria that might have preceded report generation are lost.

CONCLUSIONS

Filevision is an easy program to work with provided your data-management chores have the proper graphics orientation. In most respects, the program adheres well to the Macintosh's user-interface conventions. You can perform many selection operations in two ways: by clicking on an object and then on a menu item or by double-clicking on the object. Picture elements and text boxes respond as expected to stretching and dragging, and anyone who has used MacWrite

Filevision is easy to work with provided your database chores have the proper graphics orientation.

will immediately feel comfortable with this program's text-editing features.

Nevertheless, Filevision differs from conventional Mac practice in a few areas. I was surprised to find that it doesn't have Save or Save As options on the File menu; you must select Quit to have the option of naming and saving a newly opened file. The active file is updated from time to time during a session, so the manual advises making a copy when you begin work to preserve the starting configuration.

It would help if Filevision could import a MacPaint image as a starting point, but it cannot. You can transfer images the other way, though; you can convert the Filevision screen to a MacPaint document with the command-Shift-3 "write to disk" key sequence. The images will appear on disk as Screen 0, Screen 1, and so on.

You can also select individual objects and store them in the Mac's scrapbook. And you can carry out cut-and-paste operations in the usual way, but the clipboard itself is not available for viewing from the Edit menu. Finally, Filevision cannot use the clipboard to transfer data from a text file or spreadsheet.

Despite its departures from the norm, Filevision is an exciting new approach to information management. In my first real application, I used the program's graphics to organize some laboratory data. Despite its lack of computational power, Filevision was a tremendous help. I deal with fairly small files and ask "What can you tell me about that?" questions. The "that" is often a piece of an image, so Filevision has found a home with me—even though it will not remain my only Macintosh database manager. ■

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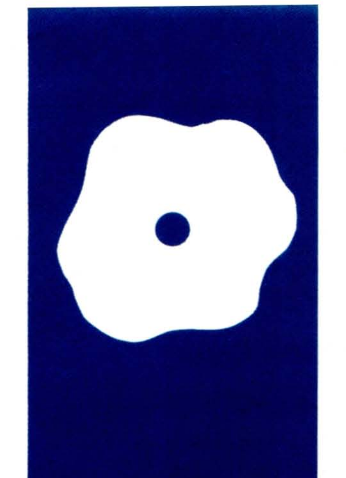
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4P019



DB *Master* *for the Macintosh*

An easy-to-use database manager with a few flaws

BY
JEFFREY M. JACQUES

Stoneware's Macintosh version of DB Master boasts easy access to the icon structure, pull-down menus, and a file size that any home or small-business user would be unlikely to outgrow—44 disks, or 20 megabytes on a hard-disk or cartridge system. Each record can handle as many as 100 fields, 3000 characters per record, and 20 complex computed fields that can include logical tests of other fields (IF . . . THEN type) and arithmetic functions such as SQRT, ABS, and RND. Stoneware's program costs $195.

Upon booting, DB Master gives you two application options, Create File and Use File. Create File lets you define the field names, data types, formulas for computed fields, and so on. Use File lets you use a file that you have previously created. The program also comes with a test file, called Cities, with three dozen fields and records for 82 cities.

When you double-click the Create File application, DB Master explains that you can either design a new form for a file or redesign a previous form. The program then presents a gray screen with the title "Design Form" and several menu options.

To design a new form, you simply click the mouse anywhere within the screen and type in the name of your first field. The program allows both uppercase and lowercase characters, and you can change the way characters are displayed on the screen by pulling down a Print Style option from the menu. The program lets you display each of the field labels (or the data in the field) in any of seven Macintosh fonts, five sizes, and six styles. Using one font for field labels and a different font, size, or style for the data lets you clearly distinguish field labels from the data in that field. The program supports the various fonts in data entry, editing, and retrieval, but not in printing reports (more on that later). Each field label is limited to a maximum of 63 characters, and you are limited to a maximum of 100 fields in a form.

When you are done entering the label, you click the mouse in another part of the screen and DB Master automatically assigns a field number to the previous field. If you wish to move a field to another location on the screen, you can choose Cut and Paste commands from the menu.

You can also use pull-down menus to set field types (alphanumeric, numeric with up to two decimal places, or date) and field length (a maximum of 21 characters for a numeric field and about 3000 characters for a single alphanumeric entry). The more fields, the fewer the number of bytes possible for any other field since the maximum record length is 3000 bytes.

Another field option, Enter Formula, allows a field to get its value from computations based on another field or fields. For example, the value of Field 3, automatically computed by DB Master at the time of report generation, might be "Field 1 − Field 2." Each formula may be up to 240 characters long, and you can have up to 20 computed fields in a form.

You can define a key field or fields, the fields by which DB Master will automatically sort records as you enter them. The key may include as few as one field or as many fields as you wish, up to a total of 40 characters for the entire key. If you do not choose a key field, the program selects the first field as the key by default.

Once you have defined all the fields, the File menu lets you title and save your form. DB Master then takes you back to the Macintosh desktop, where you can begin using your newly created form. Unfortunately, the program doesn't *ask* you if you want to quit Create File when you save the form; it automatically takes you out to the desktop, which is inconvenient if you want to create more than one form at a time.

USE FILE

When you double-click the Use File icon, DB Master presents a dialogue box with the

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names of files available for you to use. (You can also double-click on the icon for a particular file, but the program still requires you to choose the file from the dialogue box, an annoying duplication of effort.) A menu selection called Record lets you add new records, set selection criteria for a retrieval, delete records, and so on. You may also use command-key combinations to select these functions from the keyboard.

Adding a new record is straightforward, although rather slow and sometimes tedious. When you select the Add New Records option, DB Master presents you with a copy of your form and white-boxed areas for data entry. You simply enter the essential information for each field and press Return or click the mouse on a new field to move on. You can shift back and forth between fields and edit the record at any time using keyboard commands or a pull-down Edit menu to cut, copy, paste, or erase text.

When you've finished entering all the data for the first record, DB Master accesses the disk, saves the data, and gives you another blank form to fill in.

To help with the drudgery of data entry, you can select Set Field Defaults. For example, suppose you are developing a mailing list and many of the people on the list live in the same city and state; you can store the city and state names in the appropriate fields. When you ask to add another record, DB Master automatically fills in these fields with the specified text. (You can easily edit the fields when the default values are inappropriate.) This option can save considerable time.

REPORT GENERATION

DB Master lets you generate columnar reports with a wide variety of options (sort fields, column titles, tab distance between columns, etc.). The program makes it easy to select fields, organize them in order, title each field, compute sum totals and subtotals for numeric fields and counts/subcounts for alphanumeric fields, and select records based on one or several criteria.

DB Master lets you store more report formats than you are likely to ever use—255 in any file—and you may use up to 10 sort levels when creating a report. You may print reports to the screen, the printer, or a disk file that you can edit with MacWrite or Microsoft Word.

BYTE BENCHMARKS

An important feature of any database system is how fast it can sort and retrieve stored information. The BYTE standard database benchmark consists of 1000 records, each with 100 characters divided into four fields. The first field in this test was a 4-character numeric field with values ranging from 1000 to 2000. This was the key field, and the program automatically indexed records according to this field when they were entered. Consequently, sorting and retrieving records with this field was very fast.

A more accurate test is to measure a nonindexed field. For this reason, the remaining 96 characters of each record were equally divided into three fields of 32 alphanumeric characters each. The first of these three fields had 32 haphazard values entered from the keyboard, and the benchmarks were conducted using this field.

BYTE's first benchmark measures sorting speed (see the graphs on the "At a Glance" page). DB Master's sorting speed is difficult to judge since the sorting routine is couched within the larger report routine. Therefore, the elapsed time included the amount of time DB Master spent writing the output to the screen or into a text file on disk. The program took 18 minutes to print the report to the screen and more than 12 minutes to print it into a text file.

When I sort a numeric field in ascending order, I expect the most extreme negative value to be listed first, followed by less extreme negative values, small positive values, and then large positive values. DB Master, however, sorts numeric data in ascending order by listing all the positive values first and the negative values next. The positive values are sorted as I would expect. However, small negative values (for example, −1, −5) are listed before the extreme negative values (−100, −500). Figure 1 shows a profit-and-loss report for a small company during a year, sorted according to the

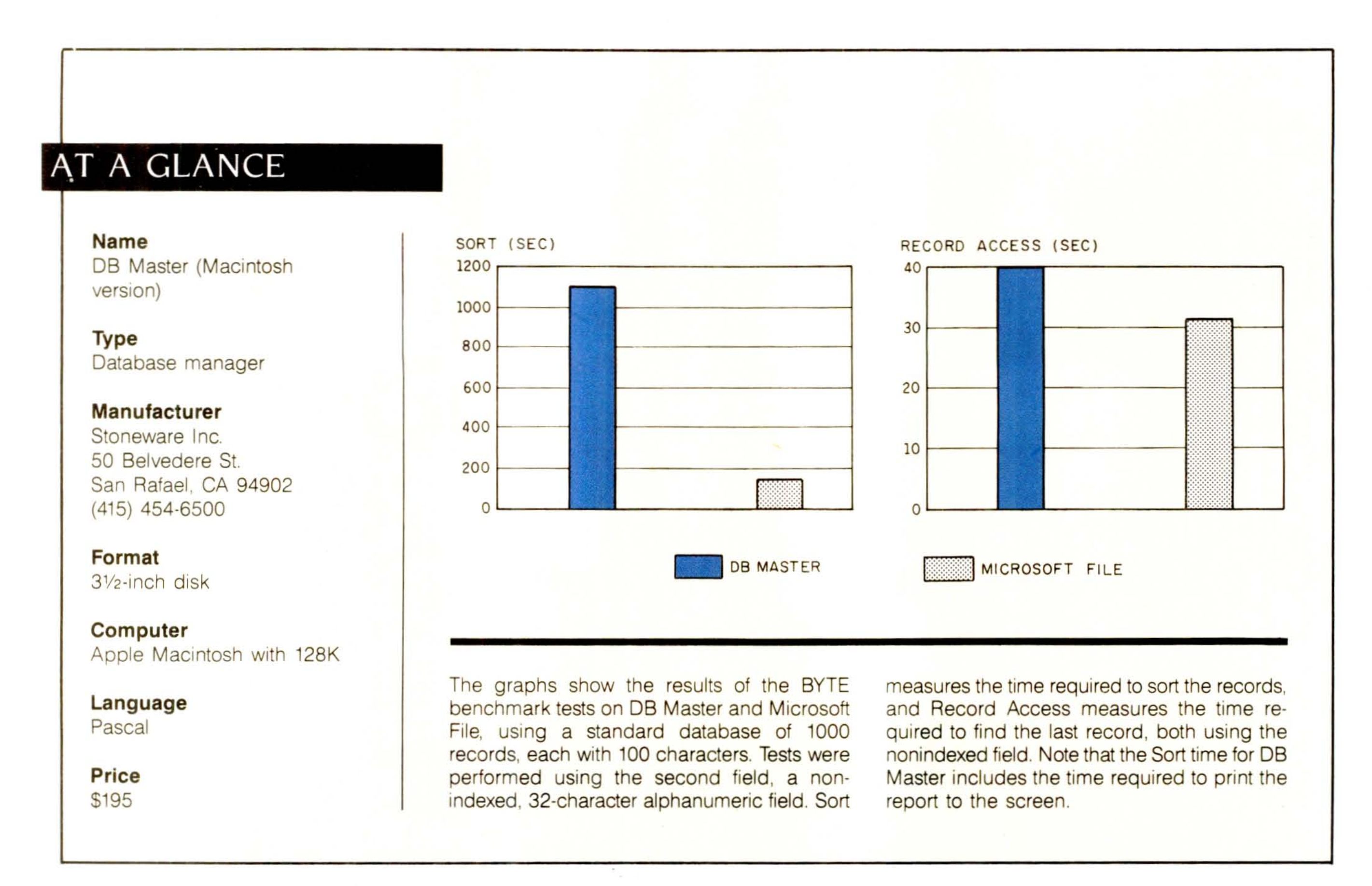
(continued)

05-17-85
Acme Widget

889.79	01-29-84
910.44	09-29-84
951.10	06-29-84
1343.22	03-29-84
1347.18	10-29-84
-6.56	12-29-84
-8.95	11-29-84
-62.22	08-29-84
-90.00	02-29-84
-110.44	07-29-84
-878.21	05-29-84
-1166.84	04-29-84

Figure 1: *When sorting numeric data, as in this profit-and-loss report, DB Master lists positive values first. Small negative values are listed before extreme negative values.*

Want to hear a demonstration of Hewlett-Packard's ThinkJet Printer?



The graphs show the results of the BYTE benchmark tests on DB Master and Microsoft File, using a standard database of 1000 records, each with 100 characters. Tests were performed using the second field, a nonindexed, 32-character alphanumeric field. Sort measures the time required to sort the records, and Record Access measures the time required to find the last record, both using the nonindexed field. Note that the Sort time for DB Master includes the time required to print the report to the screen.

numeric field $ Profit/Loss. Not quite what I expected.

The second BYTE benchmark measures record accessing. This is more straightforward. It involves finding the last record in the file (using a nonindexed field), a task that took DB Master approximately 40 seconds. Retrievals are faster when you search using the key—just about instantaneous. That should not surprise anyone since the program uses ISAM (indexed sequential-access method) file structure. The actual elapsed time in retrieving a record has more to do with time spent accessing the disk than it has to do with the software. If you have a hard disk, you'll find it even faster.

DB Master lets you search for records using the logical operators =, <, >, ≤, ≥, and <>. You can also retrieve using multiple fields and link these fields using logical ANDs or ORs. You may enter up to 20 selection criteria for any retrieval.

Closer Examination

While DB Master can do many things, there are several things it cannot do well, if at all. First, DB Master does not let you join files; that is, you cannot match records from different forms by a specific key and then retrieve unique data from more than one file. Second, designing noncolumnar reports is awkward and time-consuming and requires considerable effort. For example, handling invoice reports when you have many different entries for products for some people and few for others, as well as the need to compute discounts, taxes, and totals across items, is not easy for a novice user. Furthermore, it is difficult to print the field names and the associated data for that field when designing a report. (You have to create a new field that houses the field name as an alphanumeric entry and then print both fields if you wish to include field labels.)

Producing standard mailing labels is not difficult. You just choose the appropriate fields from your larger file, indicate that you want to start a new line for street-address information, set the page length, number of blank lines, etc., and then print the report. But DB Master works only with single labels where each label is on a separate section of the pin-fed paper. It does not let you perform any string functions, so to sort on zip code or state, you'd have to have a separate field for each. Further, the program lacks a mail-merge facility for matching names/addresses with a text or letter document.

Printed reports are strikingly limited in output styles. Your reports, if you use an Imagewriter, are limited to standard text output of pica, elite, condensed, and so on. All those fancy Macintosh fonts are visible only on the data-entry form, not on the printed report. Although DB Master supports a LaserWriter and provides a small set of additional print styles and sizes, it does not come near to using the Mac's printer capabilities. Rather, you have to dump the output to your word processor and use its editing and printing capabilities. Pretty shabby for Mac software.

One of my common tasks, creating annotated bibliographies, is difficult using DB Master. While I can define several fields as long alphanumeric data fields, thus allowing several lines of information for that field, editing facilities are incomplete. It is easy to add and delete information in fields where the number of characters is considerably below the field-length limit, but it's cumbersome to add information when the stored data is at the length limit. When I inserted ad-

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ditional information in a field that had many characters, the data at the end of the field was dropped immediately. Even if I deleted some other characters, those dropped characters did not reappear. There's no temporary storage area that would have allowed me to modify the entry—enter the needed additional information, reexamine the entry, and then delete unneeded characters—the way I typically work.

These limitations may not be important to some of you, but I found other essential applications missing, too. Perhaps the most disappointing feature of this version of DB Master is that all data entry must be done from the keyboard. Currently there is no way to directly read data from another database-management system, nor is there any way to read DIF files from a spreadsheet program. The bottom line is this: If you have a new application and have no other machine-readable data sources, then this package might make sense; otherwise, you're going to be reentering a lot of data.

DOCUMENTATION

The documentation provided with DB Master is easy reading, is generally straight to the point, and usually provides backup for what may not be apparent when using the software and the help screens. The documentation comes in two parts. The first, a 13-page document called *Getting Started*, covers the essentials of how to back up your program disk, retrieve information using the Cities file tutorial, and design, build, and retrieve data with your own form. The second and larger document, the user's guide, is good at providing worked examples and serving as an overall reference for creating a form and doing retrievals. It needs considerable work (especially for the novice user) on designing reports, thinking through issues, and developing applications.

Along with the documentation, you get a single program disk. It is not copy-protected. You also get a single-machine license agreement, a registration card, and a telephone number to Stoneware's technical support personnel.

CONCLUSIONS

Although DB Master is easy to use and has some nice features, it does not meet my expectations for a database-management system on the Macintosh. The product has the basic code to be a good file-management system, but it needs better interfacing to other software, more regard for users and their needs, better report documentation, and better use of the Macintosh's printing potential. ■


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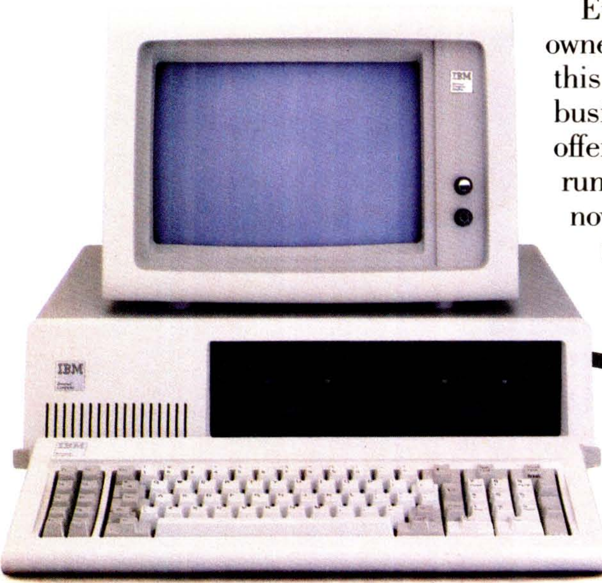
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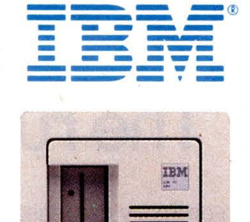
As your needs become greater, there's the mid-sized 5362 processor that offers greater performance and can handle up to 22 personal computers or System/36 terminals.

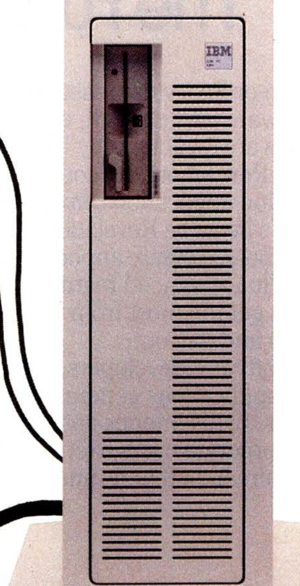
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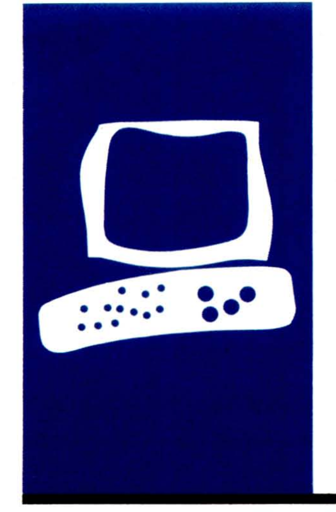
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Paradise Modular Graphics Card

A multi-function color/graphics card for the IBM PC

BY HARRY KRAUSE

Many owners of IBM Personal Computers (PCs) face the problem of wanting both the crisp display of a monochrome monitor for word processing and the color and graphics available with IBM's color/graphics-display adapter. An obvious, but expensive, solution is to have both the monochrome and color/graphics cards in your computer. A less expensive solution is to use the Paradise Systems Modular Graphics Card (see photo 1).

The Paradise card is functionally equivalent to both the IBM color/graphics card and the monochrome-display card together. It can display color on an RGB (red-green-blue) monitor and display graphics on a monochrome monitor. Paradise's card translates the 16 colors into levels of image intensity on a monochrome monitor.

The Modular Graphics Card lives up to its name by letting you plug in modules for serial and parallel ports, a game-control interface, a floppy-disk-drive controller, a clock/calendar, and additional RAM (random-access read/write memory).

I have worked with the card for several months and it has performed beautifully. Text-based programs are displayed with the same high quality I expect from a monochrome monitor, and full-size graphics automatically pop up on the same screen. The card will properly drive any kind of monitor used with IBM PCs: TTL (transistor-transistor logic) monochrome, composite monochrome, or RGB. There is no advantage, however, to using the card with either RGB or composite monitors because the display quality with these devices is no better than with the IBM color/graphics card.

INSTALLATION

The full-length adapter card is packaged with a 60-page instruction manual and a software disk. Many PC users who buy a new card just pop it into their machines without reading the manual. I wouldn't recommend doing this with the Modular Graphics Card. You have to check positions of several switches or jumpers on the card or in the PC before you do anything else. In fact, a headline on the first page of the manual warns: "If you read nothing else, read this!" The headline is followed by clearly worded instructions and an illustration of the card. Depending on the equipment you've got, some of the instructions will apply. First, you've got to let your PC know, by setting the proper DIP (dual in-line package) switch on its motherboard, that the Paradise card functions as a color/graphics adapter. Second, you must examine the Paradise card and move a jumper or two to let it know whether you're using an RGB or composite-video monitor or a TTL monochrome monitor.

Once you've set the switches and jumpers, you can insert the Paradise card into an empty slot in the PC.

For software installation, Paradise supplies a disk of files necessary to configure the graphics board to the system being used. You invoke most of these through an on-screen menu program called MGPREP. After providing instructions, MGPREP displays the main menu, which appears as a table of configuration data. You can select a monitor from a list of several selections, such as RGB/COMP, Taxan, Eagle/Amdek, and Princeton.

With the Mode option, you select the video-display mode. The list includes 80-column text, black-and-white monitor with 40-column display, and color monitor with 40-column display. The Mono Card selection is for cases where you also have IBM's monochrome-display adapter in the computer and want the machine to boot up using that card and the monochrome monitor.

The Centering menu selection lets you adjust the display for use with a television set, composite monitor, or RGB monitor. When invoked, the routine runs a centering pattern on the display. When the pattern is too

(continued)

Harry Krause (POB 596, Great Falls, VA 22066) is a marketing consultant who claims he got involved with microcomputers out of self-defense after seeing them pop up overnight on clients' desks.

AT A GLANCE

Name
Modular Graphics Card

Type
Display adapter for text and graphics

Manufacturer
Paradise Systems Inc.
150 North Hill Dr.
Brisbane, CA 94005
(415) 468-6000

Size
Full-size PC card, 13 by 4 inches; occupies one slot

Equipment Needed
IBM PC or compatible with an available slot and one disk drive

Features
Invisible shifting between text and graphics modes on TTL monitors; modular construction to accommodate add-ons

Options
Add-on modules: parallel printer port ($95), game port ($95), serial port ($95), clock/calendar and 256K RAM ($275), 384K RAM ($275), floppy-disk controller ($275)

Documentation
60-page owner's manual

Price
$395 for fully functional display adapter

Warranty
One year, limited

far to the right or to the left, you can tap the appropriate arrow keys on the computer's keyboard in order to center it.

When you are finished configuring, you can select the Install option and MGPREP will create an MGC.COM disk file incorporating your selections. MGPREP is clever enough to include another option that allows the MGC.COM file to be automatically inserted into your computer's AUTOEXEC.BAT file. MGPREP's menu also lets you set parameters for many of the options (additional memory, serial port, controller, etc.) available for the Paradise card.

Resistors and Pixels

At this point, I ought to mention an installation anomaly. I had no difficulties installing the Paradise card in an IBM PC with an IBM green-screen monitor. But I prefer amber displays, so I tried the card with an Amdek 310A. The program loaded properly, but the screen remained blank. I turned the monitor off and then

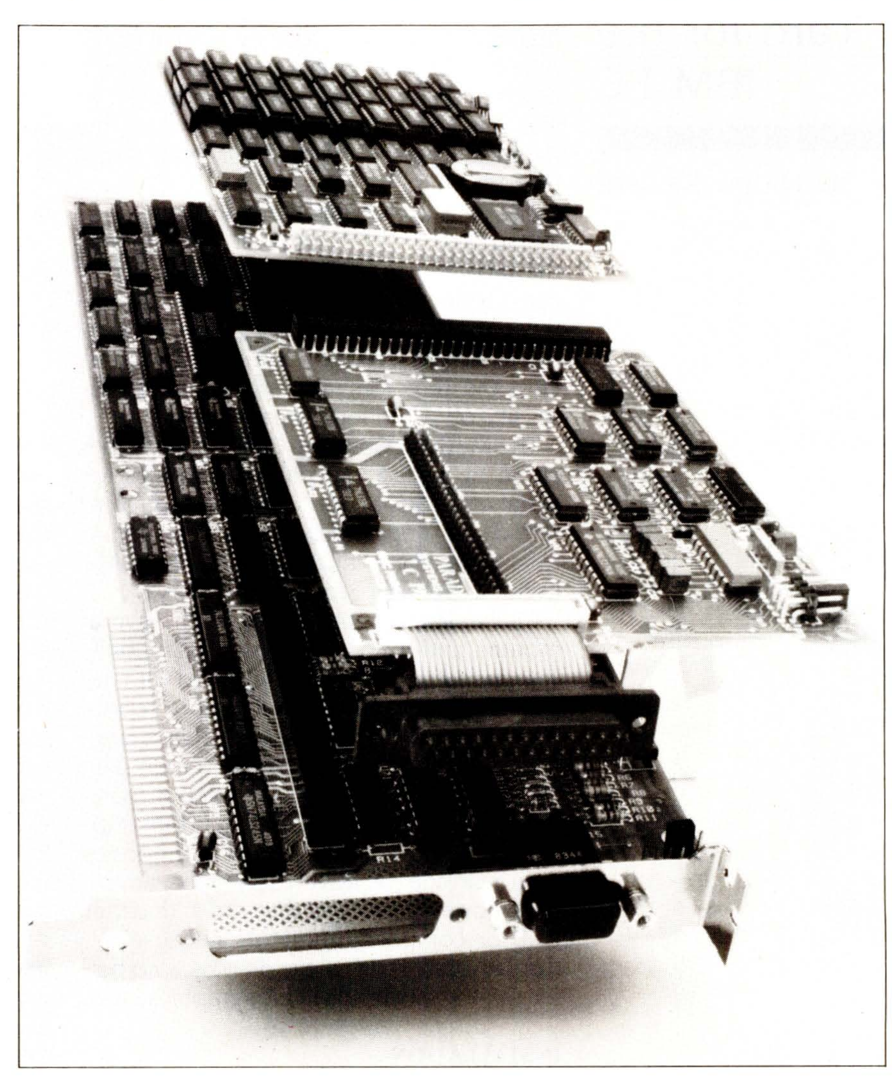


Photo 1: *Modular Graphics Card from Paradise Systems fits into any full-size slot in an IBM PC or compatible. The connector at the bottom right of the photo mates with a cable from a monochrome TTL monitor. Also shown are two of Paradise's optional add-on modules; at the top is a combination RAM/clock card, and below that, a serial adapter card.*

turned it on again—it worked fine. Puzzled, I called Paradise and spoke with a technical representative. Apparently, early versions of the Amdek 310A included a resistor-protective circuit that created a mode-shifting problem when used with boards like those built by Paradise Systems. The solution is to snip off one end of the offending resistor. Before hacking up my monitor, I verified the information with Amdek. Sure enough, Amdek had issued a service bulletin identifying the resistor as a special problem and recommended disabling it. I opened up the monitor, cut a lead off the offending resistor, and the problem disappeared. (The monitor is potentially the most dangerous peripheral because of high voltages. You might want to have a dealer make any modifications.)

My AUTOEXEC.BAT file sets several system parameters and leaves me at the operating-system prompt. Adding MGC.COM to the batch file did not seem to change anything. The characters on the display, however, were ever so slightly different than what I was used to seeing. They looked a little more squared off but were still very readable; when I scrolled through a display of my hard-disk directory, there was no flicker. Reading the Paradise instruction booklet, I discovered that, while the characters displayed in the nongraphics mode are the same size as with the IBM monochrome card (a 7 by 9 matrix of pixels), the character matrix—the matrix in which characters are formed—is 8 by 14, a tad smaller than the IBM's. The squared-off characters also appear with the Paradise card's graphics mode. The displayed characters aren't of a lesser quality than those generated by IBM equipment; they are just a little different.

I ran BASICA and then selected and invoked a couple of programs I hadn't been able to run before installing the new card. They use graphics that simply won't display on the monochrome adapter/TTL monitor combination. These are simple graphics demonstration programs I downloaded from IBM PC-oriented bulletin boards. They run now on my Amdek just as I had seen them run on graphics monitors.

I had to slightly reconfigure some of my nongraphics programs to accommodate the new setup. For word processing, I use Volkswriter Deluxe, a program with an elaborate but easy-to-use setup file that allows it to be customized for an assortment of IBM PC-compatibles and peripherals. The program's configuration file asks you to specify what type of graphics card/monitor combination you're using. I had previously set a monochrome card/monochrome monitor combination. With the Paradise card installed, I had to reconfigure and tell the program I was now using a graphics card/monitor combination. Once Volkswriter Deluxe was reconfigured, it ran without a glitch. If you're familiar with Lotus 1-2-3, you know about the selection of monitor drivers. If you've been running 1-2-3 with a monochrome adapter/monitor combination and you install the Paradise, you'll have to use the Lotus configuration program to select another display driver. The benefit will be apparent; you will now be able to display the Lotus graphics that were previously unavailable.

CONCLUSION

Between my software and that owned by my colleagues, I have access to hundreds of programs that run on IBM PCs and compatibles. I checked several dozen graphics-based programs with the Paradise and they all ran as they should; I actually did not come across a program that would not. To check on compatibility with lesser-known computers, I opened up an Eagle Turbo and popped in the Paradise card. It worked as it did on an IBM PC: beautifully.

In looking through my notes for ways in which Paradise could improve the product, I don't see much. If you follow the directions, the card is easy to install. And it performs exactly as advertised. Paradise Systems' Modular Graphics Card is one of the few products I've evaluated that I'd consider purchasing for my own system. ■

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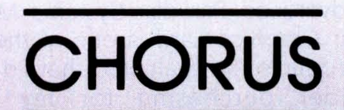
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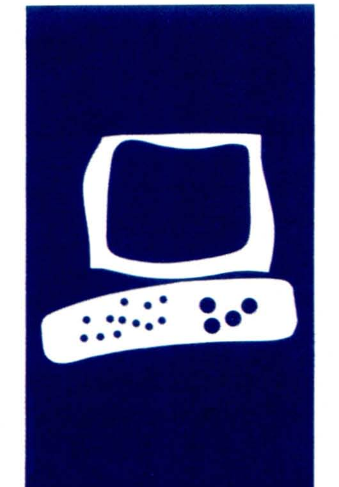
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Chorus Data Systems, Inc., 6 Continental Blvd., P.O. Box 370, Merrimack, New Hampshire 03054



The RAMDISK-64

Fast disk access on the Commodore 64 at a reasonable price

BY WARREN BLOCK

An alternative to Commodore's 1541 disk drive for the Commodore 64 is P Technologies' RAMDISK-64, which simulates a disk drive with dynamic RAM (random-access read/write memory) chips. Until now, most RAM disks that imitate small-capacity disk drives had at least 128K bytes of RAM and cost in the neighborhood of $400. RAMDISK-64 has 64K bytes of RAM, is expandable to 256K bytes, and costs only $149. RAMDISK-64 requires a motherboard expansion chassis for the Commodore 64's cartridge port. C-64s without the expansion will require an additional extender board ($10). The RAMDISK-64 with 256K bytes costs $350.

The RAMDISK-64 package includes the RAM disk itself (a rather small cartridge), a copyable disk containing the RAM disk's software, and a small user's manual. I also purchased the no-frills extender board.

First, I plugged the extender board into the cartridge port on the C-64. Then I plugged RAMDISK-64 into the extender board's socket. If you switch cartridges frequently, you should buy a motherboard with enable/disable switches for each cartridge; this makes life easier for you and your computer. The manual, which is clearly written and easy to follow, suggested that I load a test/diagnostics program from the disk. When I ran the utility, it printed RAMDISK-64 FUNCTIONAL!!! I then loaded the Fast-Drive program and ran it as instructed. Everything worked the first time through; the computer displayed RAMDISK-64's directory. In its 64K-byte configuration, the RAM drive has a capacity of 254 blocks, or about one-third that of a normal disk drive.

COMPATIBILITY

I used a straightforward procedure to check compatibility with programs that alter the C-64's operating system. After loading the version of Fast-Drive that goes at the top of BASIC memory, I loaded and tried to execute such programs. Most worked without a hitch. However, my word processor, SpeedScript, begins by clearing memory; it refused to work with the Fast-Drive software. The program worked as if RAMDISK-64 were not present. Supermon, a machine-language monitor, will not save files to RAMDISK-64. This is minor since sending object files from the assembler to the RAM drive is easier than saving them through Supermon.

In the most difficult test, I ran my assembler's initialization program, which loads the DOS Wedge, the Supermon monitor, and then an assembler. This is not a fair test because all three alter the C-64's operating system in different ways. Nonetheless, all executed perfectly, and I still had 28K bytes of BASIC memory left. This is sufficient space for an assembler development system. If you need more free memory, you can load a version of the Fast-Drive program into the 4K-byte block of free RAM at 49152 (C000 hexadecimal); this leaves the normal 38K bytes free for BASIC programming. I prefer to place Fast-Drive at the top of BASIC, keeping the 4K-byte block free for assembler programs.

USING RAMDISK-64

The RAM drive is fairly simple to use. The Fast-Drive program installs the RAM drive as device number 15, making references very similar to those used for the "real" disk drive. For example, you can view RAMDISK-64's directory by typing LOAD "$",15. Unlike the 1541, the directory is not actually loaded into program memory so it will not erase your program—one example of the forethought that P Technologies put into the product.

It is just as easy to load and save programs to the RAM drive. For example, to load the program Filename, you type only LOAD "FILENAME",15. As in the method for the 1541, you use the Open statement to scratch (delete) files. The Fast-Drive program recognizes "S:" to scratch a file and "C:" to change the RAM drive's device

(continued)

Warren Block is majoring in computers and mathematics at Chadron State College. He can be reached at 645 King St., Chadron, NE 69337.

AT A GLANCE

Name
RAMDISK-64

Type
64K-byte RAM disk for the Commodore 64

Manufacturer
P Technologies
1555 Riverpark Dr., Suite 206
Sacramento, CA 95815
(916) 920-3226

Computer
Commodore 64 and 1541 disk drive

Documentation
21-page user's manual

Price
$149
Extender board $10

Audience
Programmers and software developers, home users

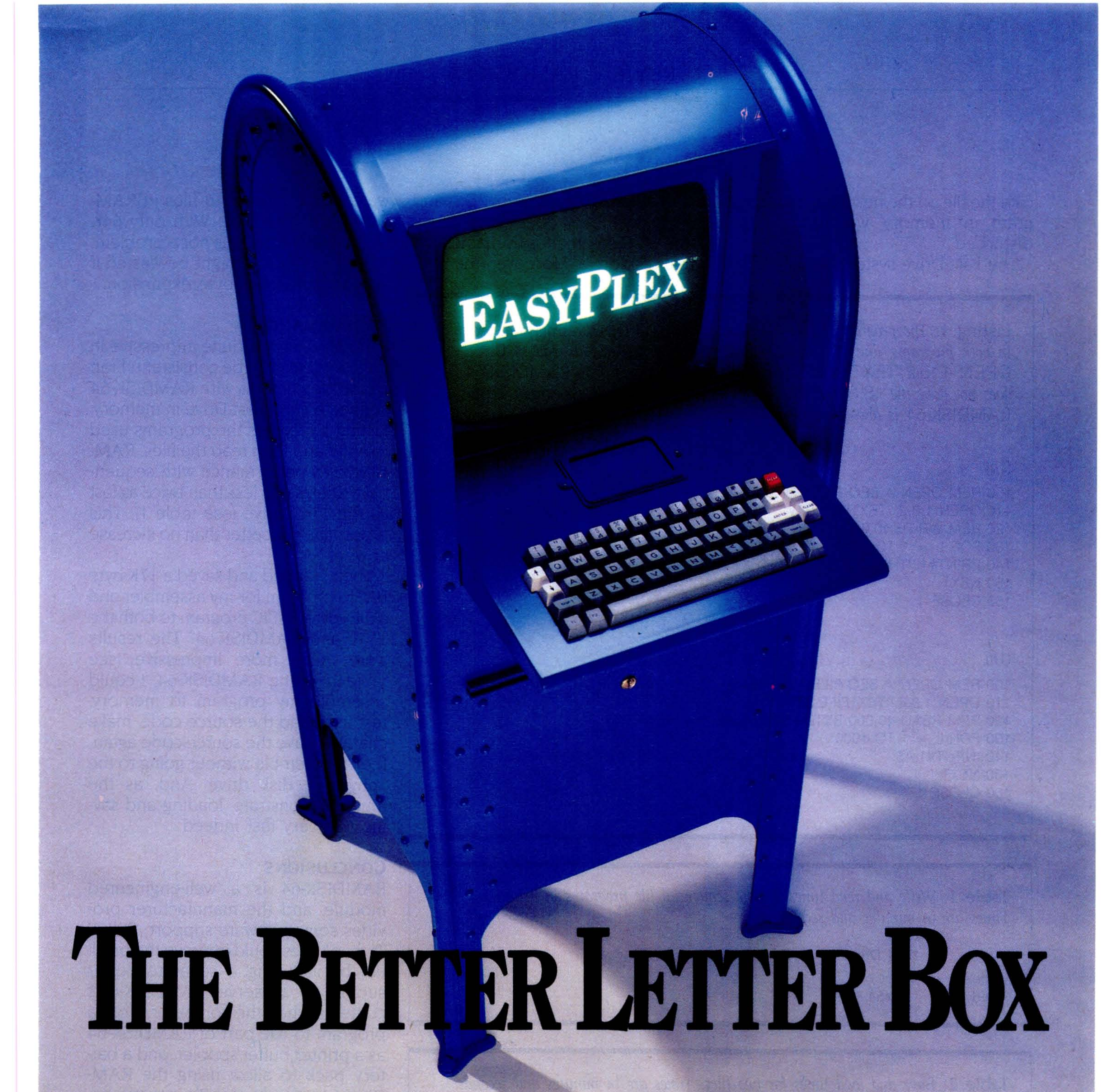
number. To scratch the file Filename, you type OPEN 1,15,0,"S:FILENAME". Typing OPEN 1,15,0,"C:20" changes the device number of the RAM drive to 20. Fast-Drive intercepts the Open statements before they get to the operating system; since they never actually open files, you don't need to close them.

The software also supports Commodore's "save with replace" command. To save a new file over an old one, you use the conventional @: prefix before the filename. The method is easier than scratching an old file and saving its replacement.

Fast-Drive includes two useful commands that let you transfer programs and text files to or from RAMDISK-64 without going through program memory. These Load and Save operations are similar to the normal ones, except that they cite RAMDISK-64's device number at the end. For example, to transfer a program called FILENAME.BAS to the RAM disk, you enter the command LOAD "FILENAME.BAS", 8,15. Similarly, SAVE "FILENAME",8, 15 saves the RAMDISK-64 contents of the Filename file to the disk in the 1541 drive.

RAMDISK-64's transfer commands let you copy text and object-code files without the usual hassle. Copying text files from disk to disk with a 1541 normally requires entering a utility program, and copying object-code files requires that you know their starting and ending addresses. RAMDISK-64 greatly simplifies the copying process. Even if you didn't know the length and starting and ending addresses of an object-code file on a disk in the 1541 drive, LOAD "FILENAME",8,15 would transfer it to the RAM drive. After you switch disks in the 1541, SAVE "FILENAME",8,15 will dupli-

(continued)



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cate the file on the new disk. Your program in memory will remain undisturbed.

The Fast-Drive system does have a few problems. Apart from "S:" and "C:", RAMDISK-64 does not have any of the DOS commands available with a real disk drive. Moreover, the software supports only 16 files in RAMDISK-64 at one time. With only 64K bytes, the limitation is not a problem, but a lot of space might be wasted if you add the 256K-byte expansion.

Listing 1: *The programs used to write (1a) and read (1b) the sequential text file. In both programs, line 110 was changed for* RAMDISK-64 *to read:* 110 OPEN 1,15,2,"TEXTFILE". *The Open statement used with* RAMDISK-64 *does not have the* ",S,R" *or the* ",S,W" *for read and write, respectively, because* RAMDISK-64 *is always open for both.*

(1*a*)

```
100 REM OPEN A SEQ FILE FOR WRITE
110 OPEN 1,8,2,"TEXTFILE,S,W"
120 REM WRITE 40,000 BYTES OF DATA
130 FOR L = 1 TO 1000
140 PRINT#1,"THIS IS A LINE OF TEXT USED AS A TEST..."
150 NEXT
160 CLOSE 1
```

(1*b*)

```
100 REM OPEN A SEQ FILE FOR READ
110 OPEN 1,8,2,"TEXTFILE,S,R"
120 REM READ 40,000 BYTES OF DATA
130 FOR L = 1 TO 1000
140 INPUT#1,A$
150 NEXT
160 CLOSE 1
```

Table 1: *Write and read times for the sequential file programs in listing 1. Times are in minutes and seconds.*

	1541 Drive	RAMDISK-64
Write	2:07	1:22
Read	1:54	1:24

Table 2: *Save and load times for two files. Times are in minutes and seconds.*

17K-byte assembler source file in BASIC format

	1541 Drive	RAMDISK-64
Save	0:46	0:02
Load	0:52	0:02

34K-byte BASIC program

	1541 Drive	RAMDISK-64
Save	1:28	0:03
Load	1:22	0:03

PERFORMANCE

RAMDISK-64 was quite impressive in the speed test. To be consistent, I ran all the benchmarks with RAMDISK-64 connected and Fast-Drive in memory. Listing 1 presents the programs used to write and then read the files. RAMDISK-64's performance with sequential text files was less than twice as fast as the 1541 drive (see table 1). This is peculiar, yet better than no increase at all.

Then I loaded and saved a 17K-byte BASIC program for my assembler and a 34K-byte BASIC program to both the 1541 and RAMDISK-64. The results were much more impressive (see table 2). Using RAMDISK-64, I could assemble my program to memory, test it, reload the source code, make changes, save the source code again, then reassemble without going to the "physical" disk drive. And, as the times demonstrate, loading and saving was very fast indeed.

CONCLUSIONS

RAMDISK-64 is a well-engineered module, and the manufacturer provides some software support. Still, P Technologies could improve the product by including a separate power supply to preserve RAMDISK-64's contents when the computer is off, a program to use part of RAMDISK-64 as a printer buffer/spooler, and a battery pack to allow using the RAMDISK-64 cartridge for file transfer between computers.

RAMDISK-64 has enhanced my programming environment by providing unusual speed on the Commodore 64. At last I can change and resave a program without the long wait for the 1541 drive. At the end of a session, I can transfer the work from RAMDISK-64 to an actual disk with little bother. RAMDISK-64 is a solid addition to the Commodore 64, and software writers will find it an indispensable aid. ■

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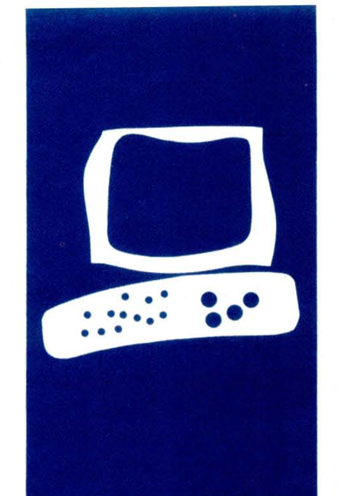
Examples of software which show dramatic speed-ups include AUTOCAD, 1-2-3™ worksheets which depend heavily on financial or transcendental functions, and multi-user operating systems. Any program written with an MS-DOS compiler that supports the 8087, such as MS-FORTRAN or 87BASIC, will run on the NUMBER SMASHER at least a factor of 2.5 times faster! Software that comes with the card also increases the throughput of I/O bound programs and includes a disk cache routine, ram disk and print spooler.

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HARDWARE REVIEW

Keyport 717

An alternative to the standard Apple keyboard

BY DAVID L. SALAHI

The Keyport 717 from Polytel Computer Products is a touch-sensitive membrane keyboard that you can use as an alternate input device to the normal Apple keyboard. It has 717 key locations that you can program to mean anything you desire. By using a plastic overlay, you can develop custom applications so you can execute functions by simply pressing the appropriate spot on the keyboard (see photo 1).

I don't expect any single application would ever use all 717 keys; that would be too confusing. Rather, you would leave blank space between some keys and make other keys "larger" by grouping two, three, or more locations together.

Using the Keyport 717 as an input device lets you avoid using the regular computer keyboard; non-typists can approach the computer much more easily. Also, with so many keys, you have that many more options available all at once. This reduces the need to traverse through menus or memorize command sequences. In addition, you can label the keys with the actual function, obviating the need to remember that D is for delete and L is for list. By grouping the keys in a logical fashion and appropriately using color and shape, you have the potential to develop a user interface far superior to anything currently available.

DESCRIPTION

Physically, the Keyport 717 is a plastic box measuring 26 inches wide by 13 inches deep by 2½ inches high at the back, sloping to 1½ inches high at the front. It plugs into the Apple's game connector so it does not take up a slot. The connecting cable is only about four feet long, however, and this limits the Keyport's placement. Since I wanted to place it on the left side of my desk and since the cord was connected to the opposite end of the Keyport, its placement was severely restricted. I would have welcomed another two or three feet, particularly when I wanted to remove it from my desk to use the standard keyboard.

Also, the Keyport's active area is only 9 by 22 inches. This amounts to about 40 percent of the top surface area that is essentially wasted space. If the unit could be repackaged without this excess, it would be much easier to fit onto a desk or other working area.

The key locations themselves are about ⅜ inch square and seem to be about the right size. In the front middle of the Keyport is a section devoted to a QWERTY keyboard so you can do all your work from it. Several plastic overlay templates define the keys with the desired meanings for various applications.

Since it is a membrane keyboard, the Keyport has no actual up-and-down key motion, so it has no "feel." This is a distinct disadvantange that I will discuss in more detail below. The manual warns that the surface is sensitive and cautions users not to place heavy objects, such as books, on it. If a heavy object is left on the unit for several days, a short or open circuit could occur and lead to malfunction. This characteristic of the unit excludes it from use in any environment where the risk of mistreatment exists (such as schools).

The Keyport works with the Apple II, II+, or IIe. I tried mine on a Franklin Ace and it seemed to work, although I had trouble running the Safari game. The Keyport does not work with 80-column cards or with lowercase.

For those who are not interested in programming new applications, the Keyport supports several prepackaged ones. These include templates for VisiCalc, Applesoft BASIC, and a new one for Apple Writer IIe. Also, two educational games for children called Safari and Farm even feature on-screen graphics and sound.

BASIC INTERFACE

The BASIC Interface is a prepackaged application with an overlay that lets you enter

(continued)

David L. Salahi is a programmer with eight years of experience in civil engineering applications and an A.A. degree in computer science. He can be reached at 90 Streamwood, Irvine, CA 92714.

AT A GLANCE

Name
Keyport 717

Type
A 717-key programmable membrane keyboard that attaches to an Apple II, II+, or IIe through the joystick port

Manufacturer
Polytel Computer Products Corp.
2121 South Columbia, Suite 550
Tulsa, OK 74114
(800) 245-6655

Size
26 inches wide, 13 inches deep, 2½ inches high in back, sloping to 1½ inches high in front

Options

VisiCalc Interface	$39.95
Farm (educational game) Interface	$29.95
Farm Interface for ECHO II speech synthesizer	$39.95
Safari (educational game) Interface	$29.95
Safari Interface for ECHO II speech synthesizer	$39.95

Documentation
30-page manual

Price

Keyport 717 with BASIC overlay and disk with configuration programs	$179

BASIC commands by pressing a key on the Keyport (reducing entire words to a single keystroke). All the standard commands are available on the Keyport and are grouped logically together into attractive color-coded areas. Areas are provided for low-resolution and high-resolution graphics, text display and printing, string functions such as LEN and MID$, arithmetic functions, disk utilities, and disk-access commands. A nice convenience is an area called Operators that contains all the keys you must normally shift (!, @, #, $, %, and so on) that can be obtained from the Keyport without shifting.

To use the BASIC Interface, you boot DOS and then boot the BASIC Interface disk supplied with the unit. At this point, you may enter any BASIC command by selecting it from the Keyport. For example, to set a color in low-resolution graphics, instead of coding a statement such as COLOR = 3, you press the purple button on the BASIC overlay. The phrase COLOR = 3 automatically appears on the screen. To code a FOR loop, press the button corresponding to FOR and the word appears. At the end of the loop, press the word NEXT and it appears.

Some useful command sequences are programmed into the BASIC Interface, such as TEXT : HOME : LIST, making graphics programming much easier. Also provided are 16 additional undefined keys that let you define your favorite command sequences.

A tutorial program on the disk walks you through the construction of a program using the Keyport BASIC Interface. The tutorial is very well done, and by the end of it I found it simple to construct programs using the device.

The drawbacks to programming with the Keyport have to do with two features inherent in its design. One is the keyboard's lack of feel. Since there is no key motion, you are sometimes not sure whether you have actually pressed a key. Fortunately the Apple's speaker is used as a key click. Still, the lack of feel limits the speed with which you can press the keys, making the Keyport less comfortable than a conventional keyboard.

The lack of feel is compensated for in large part by the reduction of many keystrokes to one or two for BASIC commands. However, you will still have to enter a fair amount of text with the regular keyboard or the QWERTY keyboard on the Keyport. It's just not practical to switch between the Keyport and the Apple's keyboard unless you enter large portions of text relatively infrequently. This means that to enter little bits of often occurring text, you must use the QWERTY keyboard on the Keyport. For this purpose, the Keyport's membrane keyboard is very slow and unwieldy. However, the user of an application program designed for the

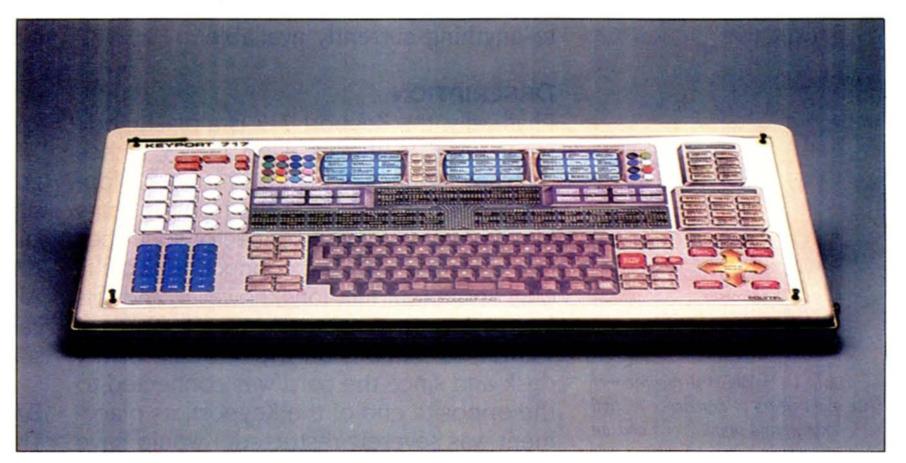


Photo 1: *The Keyport 717 with the BASIC programmer's overlay.*

Keyport would primarily be selecting functions. The entry of text would be less and the Keyport's use would be more feasible.

The other drawback to the Keyport is its large size. It is about as large as an entire Apple computer and it's not easy to find room on the average desk for a device this size. This is especially true if you want it to be in a position suited to comfortably viewing the monitor.

The Keyport is about as large as an entire Apple computer and it's not easy to find room on the average desk for a device this size.

Board Definition Program

Developing a program that uses the Keyport as an input device involves three steps. First you must design an overlay with the positions of the various functions located on the surface. For this purpose, two clear plastic overlay sheets are provided that you can write on with a felt-tip pen to lay out the positions of function buttons.

Once you have designed the overlay, you create a Key Data Table to let the Keyport monitor know what functions you have placed at what positions on the keyboard. You may assign a function number and a string of up to 250 characters to each key position. These two items will be returned to the application program whenever you press a key. Each key may have both a shifted and an unshifted code. Key Data Tables are created by running a Board Definition program. This program is very straightforward; you press each key you wish to define and enter the associated function number and string. When all the keys are defined, the table is saved on disk.

Several tables may be stored on a disk. The Hello program specifies which one is to be used when you boot the disk. It is a simple matter to create a modified copy of the Hello program that you can run at any time to load in a new data table.

Once the Key Data Table and the Keyport Monitor have been loaded from disk, an application program may access the Keyport either by using a Get or Input statement or by calling an assembly-language routine provided. Once a key has been pressed, the key number, its function number, and its associated string may be accessed. These parameters, as well as the type of key (Keyport or keyboard), are retrieved by a series of PEEKs.

Documentation

The small programmer's reference manual is not at all clear on exactly how to make use of the Keyport's functions. It seems to be disorganized so you have to keep flipping back and forth. Also, you have to read between the lines; some of the information is not explicitly stated. A novice programmer would have a difficult time trying to use this manual.

A good working knowledge of the Apple is helpful and, in fact, some assembly-language experience would be useful. For example, when the manual tells you to PEEK(513), PEEK(514), . . . , to get the string corresponding to the pressed key, it makes more sense if you know that these locations are the keyboard input buffer.

Conclusions

The Keyport 717 is an interesting concept with great potential for improving the human-machine interface. However, the execution of the concept leaves something to be desired, chiefly in the areas of keyboard feel, unit size, and ruggedness. With these caveats in mind, I recommend it for those who are looking for an alternative to the standard typewriter-style keyboard as an input device. ■

SIDEKICK COMMENTARY

Mark J. Welch's "Convenience Software" review (June, page 353) contained many serious errors regarding SideKick.

First, SideKick is available in two versions, unprotected ($84.95) and protected ($54.95). There are currently more than 300,000 SideKick users worldwide. The article's statement that SideKick "appears to be designed for programmers" is inaccurate. We are second in business software on the Softsel Hot List.

The ASCII table in SideKick hardly relegates the product's usefulness to the domain of programmers. Many of our customers use the extended ASCII character set for graphics purposes. You can draw boxes, bar charts, and the like for memos and other basic reports by marking the displayed symbols in the chart and importing them into SideKick's notepad. The Ctrl-Q-G command in the notepad will do the rest.

SideKick's auto-dial facility does not require resetting DIP switches (this change was made in September 1984). The telephone dialer in the package actually picks numbers off the screen, beginning at the top and then scanning the screen. The right-arrow key allows scrolling through numbers, and the space bar automatically brings up the Rolodex. The Rolodex functions like a free-form database and stores up to 1500 entries in any format. Addresses and comments can have any format whatsoever and take as many lines as you want. These entries can be retrieved by a keyword or string. With the current version of SideKick (1.5) you can also use the Rolodex with or without a modem.

SideKick does use many WordStar commands. However, you can redefine those commands through the installation program to look like your favorite word-processing programs.

In addition, SideKick provides two ways to print out information: Ctrl-K-P will print a marked block or the entire page if no block has been marked and Ctrl-K-W lets you write a block to any file or logical device including a printer.

SideKick's window management is more powerful than that of most products in the desktop category. With SideKick, users can shrink or expand windows and move windows around the screen. In addition, the program's main menu will appear on the screen if a hesitant user presses the Alt key without an identifier. In other words, SideKick "senses" that the user is unsure which window he or she wishes to invoke and provides the main menu to assist the user in choosing. And at any point, the user can press F1 and get the on-line help window relative to the current active window.

SideKick 1.5 contains many new features, including automatic word wrap, setting of right margin for word wrap, and reformatting paragraphs. You can also export data from the notepad into other applications in use for true cut-and-paste capability and use the Rolodex with or without a modem hookup. SideKick 1.5 supports more modems, including AT&T, VOAD keyboard phone, PCjr internal modem, and all Hayes-compatible modems. SideKick recognizes a system with two active monitors, even if one is color and one monochrome, and no reinstallation is required. You can specify a hot key to activate SideKick. Finally, this package is compatible with SuperKey and can be called from SuperKey, making SideKick a programmable desktop manager and providing you with RAM-resident macro definition and encryption capability.

PHILIPPE KAHN
Borland International
Scotts Valley, CA

As Mr. Kahn notes, the prices for both versions of SideKick were raised early this year.

I can't dispute SideKick's phenomenal commercial success, but I stand by my opinion that it was designed for programmers.

The version of SideKick I reviewed (1.10C) required that I reset the DIP switches on the modem. I'm glad this is not required in later versions. As noted in the review, I was unable to auto-dial a number picked out from another task; I assume I will be able to use this feature in the current version. I can't agree with Mr. Kahn that the standard text file used in the auto-dialer is best described as a free-form database, although he correctly points out that you can search the file for text strings. While you can use multiple lines for an entry, you can only auto-dial a number on the current line.

SideKick's notepad can print files. I'm not sure why I believed that it could not do so, but both the manual and help files explain that Ctrl-K-P will print the current block or file. I apologize for the error.

Mr. Kahn is correct in noting that you can use SideKick's installation utility program to reconfigure the word-processor commands; however, the product is shipped using the standard WordStar command set.

I'm glad SideKick has been upgraded to version 1.5 and look forward to seeing the new version.

—MARK J. WELCH
Staff Writer

As a SideKick aficionado, I enjoyed the "Convenience Software" review. Mr. Welch states that SideKick's notepad cannot paste or feed information into an application. I share his disappointment. When I began using SideKick, I searched the manual for the documentation on this feature I knew had to be there. It wasn't.

As for printing, if you wish to print only part of the notepad file, you can use the WordStar block commands Ctrl-K-B and Ctrl-K-K to mark the beginning and end of what you want to print. Then press Ctrl-K-P to print. Be sure to include the carriage return at the end as part of the block. If you fail to do so, your printer might not print the last line of the block and the tabulation of the first line of the next printed block will be wrong.

Mr. Welch states that SideKick required him to reset the DIP switches on his modem and he could not get the auto-dial feature to work. Without resetting the DIP switches on a Hayes Smartmodem, I had no problem with the auto-dialer after I inserted a "P" (for pulse dialing) before each of the phone numbers in my directory. However, after SideKick begins dialing a number, it says, "Pick up phone and press space." If you pick up the phone before the dialing sequence is completed, the call will be aborted.

I found the copy-protected version of SideKick quite cumbersome. I quickly

(continued)

traded up to the unprotected version so I could copy SideKick and an AUTOEXEC.BAT file onto each of my software disks. Loading SideKick from a second disk is too much bother.

To invoke SideKick, you press the Ctrl and Alt keys simultaneously or press both shift keys. The first method is adequate. The second is a nuisance. More than a few times I have typed a series of capital letters and found that I had activated SideKick inadvertently when moving back and forth between the two shift keys.

I look forward to the promised release of SideKick Plus, an extended SideKick that is supposed to offer multiple notepads, a window manager, a business calculator, an IRS log system, DOS filers, built-in telecommunications, and true text reformatting and blocking capabilities. Given SideKick's current capabilities, SideKick Plus might provide users more conveniences than the long-awaited IBM TopView and Microsoft Windows.

JEFFREY S. ROYER
Burke, VA

THE MINDSET PC

I would like to correct a misleading impression left by Tom Wadlow's recent review "The Mindset Personal Computer" (June, page 324). Limicon's $500 ProDraw graphics software is the basis of the new television game show "Catch Phrase," not Lumena and GW-BASIC. In "Catch Phrase," the contestants must guess the phrase suggested by a short ProDraw "cartoon" containing a visual pun. Each day "Catch Phrase" will need 25 completely new, high-quality, animated puzzles. Only ProDraw gave the show's producers the ability to turn their idea into a television show.

A single studio technician uses other Limicon software to control the various puzzles and special effects in response to the contestants' puzzle selections and answers. The Mindset is being used on "Catch Phrase" because ProDraw graphics look better on it than on the IBM PC and because it has a good NTSC video signal.

HOWARD GOODMAN
Limicon Inc.
Toronto, Ontario, Canada

Thank you for your review of the Mindset PC. It presented a good introduction to one of the best-kept secrets in computerdom.

I purchased a Mindset nearly a year ago, largely on the strength of BYTE's product preview (April 1984, page 270). I was looking for a machine that provided a standard video output, a fast true 16-bit processor, and 16 colors in medium resolution. I planned to use the system to produce animated software tutorials on video cassettes. I looked at many other systems, but not one met all my criteria in the form of a single off-the-shelf package like the Mindset.

This machine has far exceeded my expectations. In addition to giving me everything I needed, it gave me a much-enhanced version of MS-DOS with built-in graphics primitives and animation functions, and graphics hardware features that include double-frame buffering and a graphics coprocessor that is unmatched in any other machine in the same price range. In spite of the many new graphics products that have come to market since I got my machine, the Mindset is still a

(continued)

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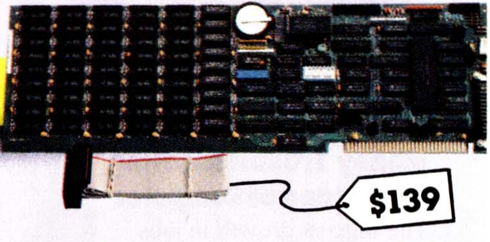
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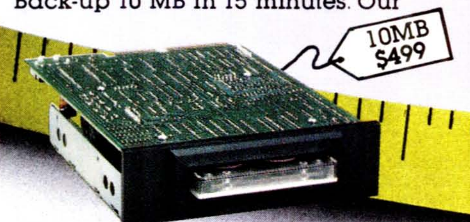
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leader, and it's getting better all the time.

Mindset has recently released several new products that were not mentioned in your review. They include a 128K-byte memory-expansion module, a 10-megabyte external hard disk, an analog RGB interface, and a real-time color video-image digitizer.

Mindset is now marketing to video and graphics professionals and other people who realize that there is life after MacPaint. It is doing much better for the change in focus. These are people who need a system like the Mindset and can appreciate its unique capabilities.

TIM NEGRIS
First Mindset Users Group
Walnut Creek, CA

Tom Wadlow's system review of the Mindset Personal Computer contained many errors. Mr. Wadlow states that only a mouse was available for review. He neglected to say that it was his fault and not Mindset's. I own a joystick along with the mouse and so know that joysticks are available.

The BASIC Performance test states that the Sieve takes 301 seconds to calculate prime numbers. I used BYTE's corrected version of the Sieve and it ran in 191 seconds—the same as the IBM PC. How could this discrepancy occur? A reader would conclude that the Mindset was almost 20 percent slower than an Apple IIe.

Next, the reviewer announces the Mindset's failure to run Microsoft's Flight Simulator. Had he reviewed Mindset's compatibility chart, he would have realized that this software would not work on the machine. Most of today's better software addresses ROM, but Flight Simulator directly addresses the hardware, making it impossible for the program to run on anything but an IBM clone, which, fortunately, the Mindset is not.

In the text box, Rich Malloy states that "consumer-oriented software such as games has not been developed." Vyper from Synapse Software is an outstanding example of the Mindset's graphics capabilities and it uses a joystick. Odesta has a chess game with three-dimensional graphics.

In the "At a Glance" section, the optional software includes only MS-DOS, BASIC, and Lumena. Over 160 of the most popular PC titles run on the Mindset as well as graphics programs such as 4-Point Graphics Plus (stores images and plays them back sequentially), CADDraft (engineering and architectural scaled drawings with overlays), and Designer (roughly similar to PC Paintbrush). Also, the Price section incorrectly states that a monochrome display is part of the usual configuration.

In the future, please make sure that your reviews have been well researched and provide accurate and reasonably complete coverage of the product. I own a Mindset, and I wouldn't want to own an IBM clone at half the price.

MARK JOHNSON
Bryan, TX

Mark Johnson raises some points that I feel I should address. First, authors do not deal directly with the company involved in a review. All equipment is sent

(continued)

directly to BYTE and then shipped to the author writing the review. When I review a product, I can judge it only on the components that were shipped to BYTE. Mindset chose not to include a joystick in the review package. The best I could do was mention the existence of such a device.

Mr. Johnson and I agree that it is unfortunate that Microsoft's Flight Simulator does not run on the Mindset, although Mr. Johnson seems annoyed that I chose to point this out. I did not expect Flight Simulator to run. In fact, I expected it to fail for the reasons that Mr. Johnson points out. Nonetheless, I tried it, rather than assuming it would fail, and reported the results. In the first paragraph on page 329 of my article, I point out that a great deal of IBM software runs directly on the Mindset with no problems.

Mr. Johnson also correctly points out that 301 seconds is far too long for the Sieve of Eratosthenes. However, 3 minutes and 1 second (181 seconds), which is the number I measured, is much more realistic. I apologize for the error, which occurred during the editorial process.

I am pleased that Mr. Johnson enjoys the machine he chose to buy. I am sorry he found so much to disagree with in a review that basically echoes his feelings on the Mindset PC.

—Tom Wadlow
Livermore, CA

The Compaq Deskpro

I paid $2370 for my Compaq Deskpro Model 2 (two 360K-byte drives, 256K bytes of memory) from a full-service dealer, and it was a better buy than an IBM Personal Computer comparably equipped at almost any price. The engineering thoughtfulness of the Deskpro speaks as loudly as its performance. I thought that reviewer Jerry Grady gave a fair assessment of it (May, page 260). However, I would like to emphasize some grievances for the benefit of potential Deskpro buyers.

Foremost, while the machine documentation is pretty, it is nearly useless. There is no technical manual and Compaq refuses to make one available. An example of frustration: The manual gives not a clue as to how to set the configuration switches for a third disk drive (e.g., RAM disk) and implies that such a configuration is not possible.

The keyboard is cheap-looking plastic that actually rattles when it is moved. The keys are so difficult to use (especially the space bar) that a touch-typist will certainly have to replace it. The green monitor had such a long-persistence phosphor that screen-update ghosts made word processing impossible. A second green monitor was the same. I finally switched to amber, which is satisfactory. A Hercules high-resolution graphics card will not run on the Compaq Deskpro because of an addressing conflict. Other graphics boards will run.

I have had significant problems running large complex dBASE II programs on the Compaq Deskpro. Even in its retarded 8088 mode, the machine seems to confuse dBASE on deeply nested procedure calls and on rapid screen updates. The programs run fine on an IBM PC and a Zenith 150. I have been unable to get


(continued)

Inquiry 162

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	M2SDS	TURBO 3.0
COMPILE SPEED (MIN:SEC)		
30 LINES	0:09.00	0:02.00
360 LINES	0:25.00	0:05.00
EXECUTION SPEED (MIN:SEC)		
SIEVE	0:13.92	0:15.26
FIBONACCI	0:53.49	1:49.74
30X30 MATRIX (8087)	0:08.84	0:19.28
FP OPERATIONS	0:52.12	0:31.75
FP OPERATIONS (8087)	0:01.97	0:06.21
SYNTAX CHECKING EDITOR	YES	NO
MULTIPLE WINDOW EDITING	YES	NO
EDITOR FILESIZE LIMIT	MEMORY SIZE	64K
COMPILE ERROR CALLS EDITOR	YES	YES
LINKER	YES	NO
PRODUCES .EXE FILES	YES	NO
EXECUTABLE CODE SIZE LIMIT	DISK SPACE	64K
DOS ACCESS FROM EDITOR	YES	NO
DOS ACCESS FROM PROGRAMS	YES	LIMITED
8087 SUPPORT STANDARD	YES	NO
COPY-PROTECTED DISK	NO	NO
COST WITH 8087 SUPPORT	$80.88	$109.90

Source: Software Resources, Inc.
Sieve program from BYTE, January 1983.
Fibonacci program from Dr. Dobb's Journal, February 1985.
Matrix program from BYTE, October, 1982.
FP Operations program from BYTE, May 1985.
Turbo Pascal without 8087 uses only 6-byte accuracy for type REAL; M2SDS with or without 8087 uses 8-byte accuracy.
Programs compiled with all checking options on.
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Listing 1: *A self-timing version of the Sieve of Eratosthenes benchmark.*

```
  2 REM: "SIEVE"
  5 CLS:CLS:COLOR 15,1,1:WIDTH 40
  6 KEY OFF:CLS
 10 PRINT;TAB(4);"The Sieve of Eratosthenes Benchmark":PRINT
 20 SIZE=7000
 30 DIM FLAGS(7001)
 40 PRINT "Start one iteration":PRINT:PRINT TAB(4);TIME$
 50 COUNT=0
 60 FOR I=0 TO SIZE
 70 FLAGS(I)=1
 80 NEXT I
 90 FOR I=0 TO SIZE
100 IF FLAGS(I)=0 THEN 180
110 PRIME=I+I+3
120 K=I+PRIME
130 IF K>SIZE THEN 170
140 FLAGS(K)=0
150 K=K+PRIME
160 GOTO 130
170 COUNT=COUNT+1
180 NEXT I
190 BEEP:PRINT:PRINT "Done: ";COUNT;" Primes found":PRINT:PRINT TAB(4);
    TIME$
```

Microsoft Word to use the 9 by 14 high-resolution character set, and the 8 by 8 set that Word wants to use is intolerable. Word uses the 9 by 14 character set on the Zenith 150.

Despite these problems, I can endorse the Deskpro. Having graphics on the monochrome or color monitor is great and compatibility is 99 percent. The machine is fast, quiet, well crafted, and not from IBM.

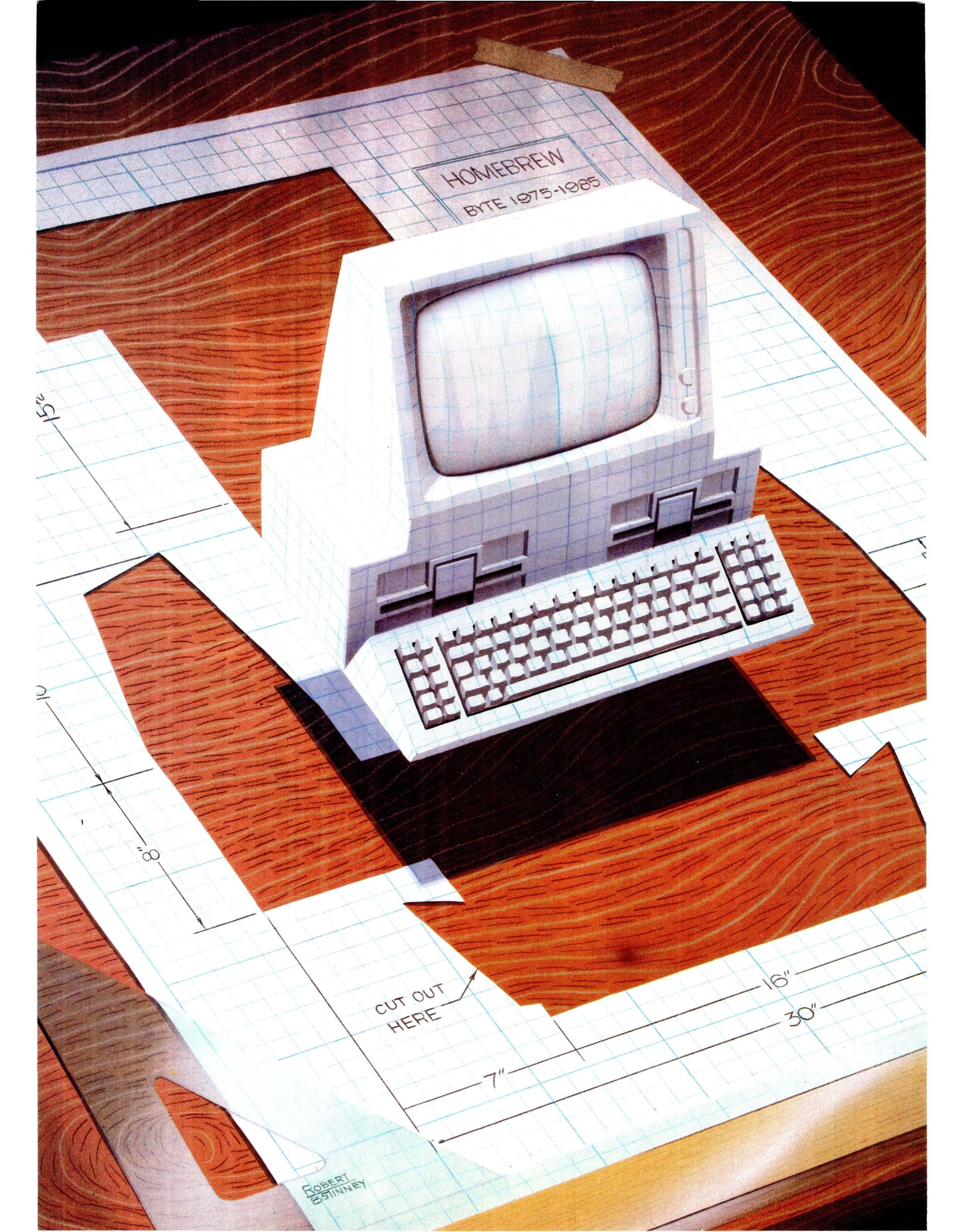
WILLIAM A. ADAMS
Seattle, WA

ANOTHER SIEVE

Listing 1 is a small variation on the Sieve of Eratosthenes benchmark. I feel that any self-respecting benchmark should at least be self-timing.

L. CRAIG REDMOND
Chicago, IL ■

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BYTE 1975-1985
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8"
CUT OUT
HERE
16"
30"
7"
ROBERT
TINNEY

Kernel

The ongoing construction work at Chaos Manor made it desirable for Jerry to escape yet again. He attended a joint press conference held by Microsoft and Apple in New York. The product introduced at the conference, Excel, is a spreadsheet for the Macintosh. Comments made at the press conference caused Jerry to put down some thoughts on software integration and whether or not we need it. He also looked at several new products, including a new version of BASIC from the inventors of the language.

This being our anniversary issue, Dick Pountain brings us a condensed history of personal computing in Great Britain. He also introduces us to a rugged new lap-held portable, the Husky Hunter.

From Japan, Bill Raike sends us an abbreviated history of that country's microcomputers and also discusses an innovative new product from Brother Industries—the SV-2000 Software Vending System.

In this month's According to Webster, Bruce describes his experiences at the West Coast Computer Faire. He discovered that it isn't as much fun as it used to be, but he found some interesting products on display. He also discusses Apple's plans for the Macintosh, predicts success for the Amiga, and looks forward to testing a host of new products.

Bob Kurosaka discusses the world of transcendental numbers in Mathematical Recreations. Some of them are familiar to us, such as e, the base of natural logarithms, and π. He looks at some hiding places for these two numbers and some ways to approximate their values.

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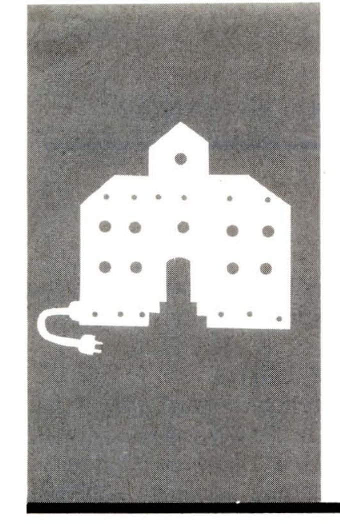
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BY JERRY POURNELLE

More years ago than I care to remember, "Everything takes longer and costs more" was known in the aerospace industry as Pournelle's Law of Costs and Schedules. (Poul Anderson claims independent discovery.) I've since seen it stated as Cheops' Law, and on reflection I'm willing to concede that since the old pharaoh had to deal with architects and contractors, he probably was aware of it.

In other words, I'm still not in my new offices. I've moved upstairs, but everything—including me—is crammed into the storage room. It's frustrating. Tony Pietsch has my new PC Video board, Concurrent DOS, and even an experimental UNIX for my CompuPro. A new Hewlett-Packard machine and ThinkJet, the AT&T 3B2/300, and the Eagle Turbo PC all sit in my electronics room—but the room is so filled with boxes of books that I can't get into it. Two Macintoshes, one with HyperDrive, the other with MegaMac and a Corvus hard disk, sit in one corner of this room, while on shelves above them is arrayed a vast quantity of new and wonderful MacSoftware—but I can't get to the machines. Sigh. At least I don't have to put up with raspberry carpets.

There's not even an end in sight. The only thing left to do is the floor, but with the new parquet floor partially in place problems developed, and they may have to take it up and start over. Meanwhile, new crews show up on weekends without appointments. I'm fighting to stay sane. I really am.

QUEST FOR CAFFEINE

Time was that computer companies made their major announcements at the West Coast Computer Faire or the National Computer Conference (NCC). When COMDEX got bigger than both NCC and the Faire, it became the place to show new wares. Lately I've noticed a new trend: companies hold their own press parties, sometimes in San Francisco, often in New York.

I seldom go to these things, which generally turn out to be long on hype and short on information. However, when Microsoft and Apple announced a New York joint press conference to be attended by Apple's Steve Jobs and Microsoft's William Gates, I was a bit intrigued. I was going to Atlanta for COMDEX three days later anyway. A week before the press conference, Pam Edstrom of the Waggener Group PR firm called to ask if I'd be coming. Just as I picked up the phone, a carpenter began hammering. The monitor screen flickered as someone else turned on a buzz saw. Suddenly it seemed like an excellent idea to be somewhere else.

The conference started at 10:30 a.m. in the Tavern on the Green in New York's Central Park. By my internal clock 10:30 was 7:30, a ghastly hour under any circumstances. Naturally I overslept. The front desk of the New York Athletic Club informed me that New York's taxi drivers were putting on a demonstration, and there were no cabs to be had. I'd have to walk to the conference, and there'd be no time for coffee or breakfast.

That didn't seem important. This was a press conference, right? The first rule for dealing with the press, particularly out-of-town press people, is to have lots of strong coffee. I walked briskly to the Tavern, arriving at 10:15—and found to my horror that although the PR staff had coffee, there wasn't any for the guests. There wouldn't be until after the press conference, at which time there would be an open bar and a free lunch.

I didn't think I'd live that long. As Barry Workman says, "The first cup of coffee recapitulates phylogeny." The prospect of listening to speeches without that first cup was more than I could bear. Fortunately, I found a sympathetic headwaiter, else I'd have nothing to report.

The moral ought to be clear: they can skip the open bar and free lunch, but it's cruel and unusual punishment to invite people to

(continued)

Jerry Pournelle holds a doctorate in psychology and is a science-fiction writer who also earns a comfortable living writing about computers present and future.

listen to any kind of speeches in the morning without plenty of coffee.

Look Out, Lotus

The conference began with a fair amount of hype. My notebook says: "Claims they will set new standards. Most advanced product available. Most etc. 'We sell lots of stuff. We're going to sell even more.' Ten minutes of snow. I still don't know what the product is. More snow. Does he really believe anyone is interested? YE GODS!!!" Of course, it's possible that I wasn't yet fully awake.

Eventually we were told what we were going to see: Excel, a new spreadsheet for the Macintosh. Microsoft President John Shirley said it would be "the world's best spreadsheet." Somehow his saying that didn't surprise me.

In the midst of all the superlatives, Shirley showed an interesting chart. It didn't stay up long enough for me to copy it; I wish it had, because with it came the most interesting remark of the press conference. "Excel," Shirley said, "is an example of our new policy of producing appropriately integrated products." The accompanying chart contrasted Excel with fully integrated programs like Symphony and Ovation.

Next up was Microsoft's founder William Gates. "Why not do all-in-one fully integrated programs? Because there are limits," he began. "Hardware has improved wonderfully, but if you try to do everything at once you soon run up against the limits. We've found that what users really want are a common user interface so that the same command philosophy works with a variety of different kinds of programs; the ability to interchange data between programs; and the ability to run several programs at the same time."

"Yeah, something like Concurrent DOS," I thought to myself. But he was certainly correct.

"Instead of trying to do it all in one program, we're using the new Macintosh Switcher program, which will be bundled with Excel," Gates continued.

"Switcher's not released, except to

(continued)

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some developers," thought I. Switcher—I haven't actually seen it operate yet—is said to do for the Macintosh what Concurrent DOS does for the PC, but do it smoother, and of course it employs "the Macintosh philosophy." Thinking about Switcher lost me a couple of Gates's sentences.

"...bringing out the world's best spreadsheet and bundling in the Macintosh Switcher program. That way users can run Excel and their favorite text editor, database, and communications program. They're not locked into one program," Gates was saying.

I glanced at my watch. Sixteen minutes since the conference started. I had a page of notes, but nothing worth writing about. Even the speakers sounded bored. Couldn't they see they were losing the audience? But of course they couldn't. Every 20 seconds a maniacal photographer with an incredibly noisy thyristor popped his flash; once I counted nine flashes in less than three minutes. I came to New York for this?

Then, suddenly, the Macintosh projector was fired up. "They've got a great projector," I wrote.

"Excel has 16,000 rows and 256 columns," Gates said. I perked up. There was an unmistakable change to his tone. He wasn't bored anymore.

Using a 512K-byte Macintosh and dual floppies, but no hard disk, Bill Gates put Excel through its paces. Numbers flashed up on the screen. Cells were recalculated. Now I was really interested. Those recalculations went *fast*. "The 68000 is fast," Gates said. "And Excel keeps track of the data structure so it recalculates only the relevant cells."

My next note says, "I guess I'm impressed."

I was, too. Do understand, I was watching a demonstration of a not-yet-released program running a live but well-rehearsed (there were photographs of the very same screens in the press kit) demonstration. The photographer maniac popped his flash so often that not only couldn't I reflect on what Gates was saying, I found it

(continued)

hard to follow his talk. On the other hand, after the conference when everyone else headed for the bar, I found Jabe Blumenthal, the Excel program manager, and got my own demonstration on a machine that I know was a normal 512K-byte Mac with floppies; and I was still impressed.

Excel is fast, it's simple to use, it has really impressive automatic charting capabilities, and, best of all, it turns macro building from a chore into child's play. That is: a macro is a user-built procedure. Lotus 1-2-3's macro capability is one of its most powerful but, alas, most difficult-to-learn features. Excel does things differently. You can cause Excel to remember exactly what you're doing, including things like "increment date," and give that set of procedures a name. You have now built a macro. You can run the whole complex pattern again simply by invoking the name. The example Gates showed was updating monthly sales data: input the new data and invoke the macro. The months are incremented, everything is shifted over a column, charts are prepared, averages taken, etc. In my own private play with Jabe Blumenthal, I built a financially meaningless but highly complex macro involving extensive calculations. It worked fine.

Something else impressed me. Bill Gates likes the program, not because it's going to make him a lot of money (although I'm sure it will do that), but because it's a neat hack.

Excel may just do for the Macintosh what VisiCalc did for the Apple II. Assuming that it works as I saw it, Excel will certainly make the Mac into a serious business machine. Spreadsheets are important to business. I'm told that about half the IBM PCs are sold with a copy of Lotus 1-2-3. From everything I saw, I'd rather have Macintosh with Excel than the PC with Symphony. I'd even prefer it to my CompuPro with SuperCalc.

WHAT DO WE WANT, ANYWAY?

I don't usually write so much about an unreleased product, but John Shirley's remark about "appropriate integration," followed by Gates's comment on limits, set me to thinking. What do we—as users—really want out of these machines, and what limits our getting it? I've in no way reached any final conclusions, but I do have some thoughts.

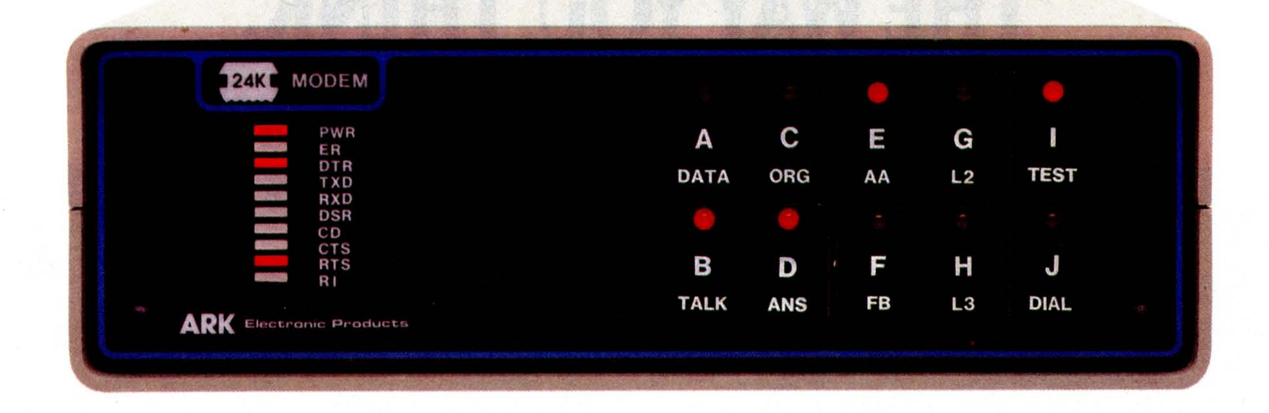
I believe Bill Gates was right when he said that fully integrated software is a dead end. Even without machine limitations it's going to be difficult to sell full integration to users. There's just too much to learn. Old hands looking for an improved text editor may not care to change spreadsheets. Newcomers almost certainly won't want to learn about spreadsheets, databases, text editors, and communications all at once; heck, I'm reluctant to take on such a formidable task myself. It's better to learn by accretion.

When we look at the individual parts of integrated programs, the situation is even worse. Perhaps you could have "the world's best spreadsheet" in your integrated package; perhaps you could even add "the world's best communications program"; but what do you do about text editors and databases? You *can't* include "the world's best text editor" because there isn't one. World's best at *what*? I know of at least five text editors that could claim to be "world's best" for one or another use, and while WordStar isn't "world's best" on any one feature, it's on so many machines, and comes in second with so many features, that it's a contender overall. The same is true with database programs. Several are good enough, and a couple are superb in one way or another—Savvy, for example, is wonderful for people who can't spell and can't remember precisely how things were stored—but if there's one that deserves the title of "world's best" at every application, I don't know which one it is. How, then, can an integrated software package have the "best" when you can't define what "best" means?

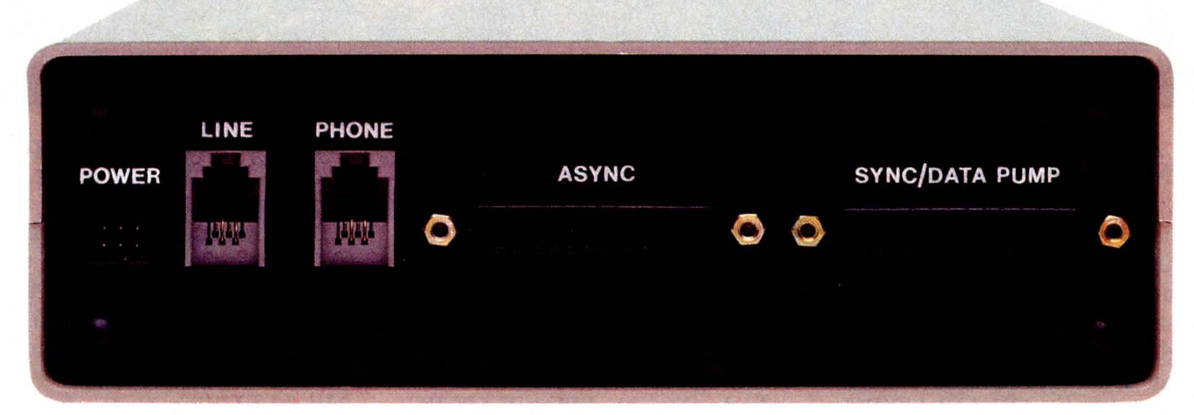
So. Fully integrated software isn't the answer, because users want to be able to pick and choose programs according to their particular needs. On

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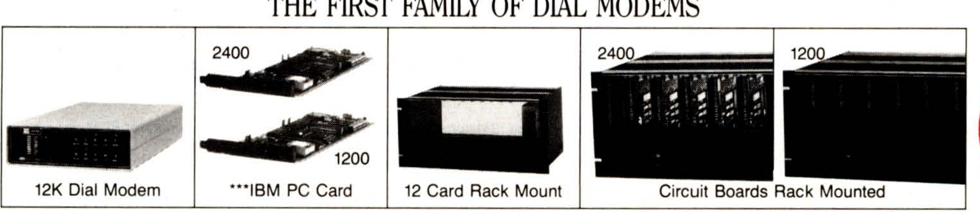
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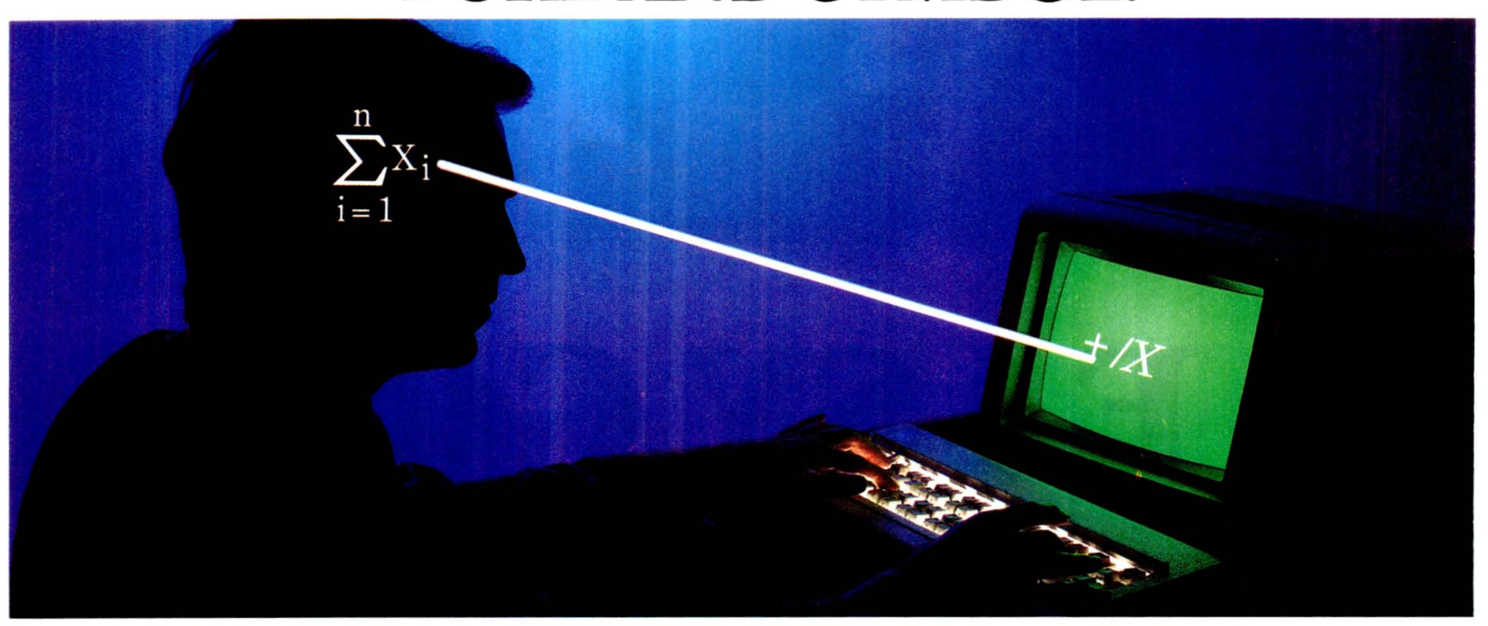
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the other hand, databases, text editors, spreadsheets, communications packages, and chart-making capabilities *are* interrelated. It makes little sense to have rudimentary capabilities for each function in each of five (or more) different programs, and it's sheer drudgery to learn how to do the same thing five different ways. Clearly, it would be better to have a good chart maker and pass it data from text editor, spreadsheet, or database; to use your favorite editor to write the text generated from a spreadsheet and be able to transfer both charts and spreadsheet calculations into the editor; and to be able to send the whole *fershlugginer* mess out through your favorite communications package. Full integration may be undesirable, but some measure of integration is still needed.

Second, it's still easier to learn by accretion. Sure, I managed to learn CP/M, WordStar, WRITE, dBASE II, SuperCalc, and a myriad of other programs, but then I'm a computer enthusiast. Moreover, having invested all that time and energy into learning to do things in certain ways, I'm reluctant to spend the time it takes to learn a lot of the new programs. Of course I eventually bite the bullet because I'm naturally curious, but I sure do get tired of learning new ways to do the same old things. If programs did most things with the same commands and in a logical and consistent manner, reserving novelty for the uniquely *new* things the program does, I'd be happier and so, I suspect, would everyone else.

Finally, most of us might like to work on one thing at a time, but in the real world we tend to be interrupt-driven systems. Sit down to write, and the phone rings: someone wants someone else's telephone number. Start to work on a spreadsheet, and you're sure to remember a phone call you ought to make. Begin one task, and you'll find a sheet of paper reminding you of something that has to be taken care of right now.

It isn't so much that we want to be able to run more than one program at a time, but that we want to go back and forth among tasks without long waits and distractions. I don't like it much when the phone interrupts my writing, but it's sure a lot better for me—and thus for whomever has called me—if I can deal with the call quickly and easily without having to search for notepaper, address book, calendar, and the like.

Epson tried to integrate all those functions with Valdocs, and while the idea had merit, the execution was fatally flawed. It took too long to save off the last job and get to the next, and it wasn't easy to transfer data from one task to another. Even in Valdocs 2.0, they suggest that you integrate the chart maker with the text editor by means of scissors, paste, and a copy machine. Valdocs was an early attempt at integration. Even in conception it had one major flaw. If Valdocs couldn't do the job you wanted—and certainly it couldn't do everything—you had to exit the Valdocs environment and cope with an entirely different operating system unrelated to what you'd already learned.

Another approach is typified by Borland's SideKick: use your favorite programs in conjunction with a set of utilities resident in high memory. The utilities can be called into a "window" on screen at any time. The job you're doing is interrupted for the moment, but as soon as you exit SideKick you're right back where you were when you called it. SideKick does an excellent job of handling notebook, calculator, phone book, and schedule. It can even pass data around within its parts. The new version has a limited capability to pass data among "foreign" programs like Lotus 1-2-3 and WordStar. However, while SideKick's command structure is logical, it isn't necessarily related to the programs you want to use. I'd rather use SideKick, 1-2-3 or SuperCalc, XyWrite, dBASE II, and MITE than any of the integrated programs I've tried, but I really want a lot more integration than the combination gives me. The SideKick method is a good one, but it doesn't go far enough.

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It seems clear to me that the best approach is to integrate software through the operating system. It's hardly a new idea. UNIX allows pipes, in which the output of one program can become the input of another, and boasts a bewildering array of utilities that programmers can call. Alas, UNIX is big, slow, and cumbersome. It's hard to use. UNIX has so many adherents, particularly among hackers, that it can't be ignored, but I'll be much surprised if UNIX is the answer to software integration.

The Macintosh operating system started out in the right direction. It may even get there. The problem was that the 128K-byte Macintosh had a number of silly limitations that Apple tried to pass off as features, when it was plain to all that they were bugs. If they could try to make you believe that, what else were they doing to you?

The 512K-byte Macintosh, especially with hard disk, is a different proposition. There really is a lot to like about the Macintosh operating system. Not only is it easy to learn, it provides a unifying approach to the command structure of any application program. The Macintosh operating system has an automatic means for transferring data from one program to another. Given that the Switcher operates as advertised—and Microsoft seems satisfied that it does—then the Microsoft/Macintosh path to integration looks pretty good.

That's fine for Macintosh. Those who have IBM PCs and PClones haven't anything like the Macintosh operating system just yet, but there are plenty of developments. Microsoft promises the often-announced Windows integration Real Soon Now. There are new signs of life at Digital Research. I'm not convinced that making the PC into a Macintosh look-alike is the right way to go, but there's another. Concurrent DOS is reaching out to engulf PC-DOS. It will then spread even further to integrate with UNIX. If AT&T can really develop a standard UNIX business shell, the PCommunity will be ready.

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There's another dark horse in the wings. The Modula-2 operating system, which grew from the same inspiration as Macintosh's operating system (namely, the work of Alan Kay at the Xerox Palo Alto Research Center), keeps popping up in unexpected places.

We don't as yet have an acceptable software-integrating operating system, but maybe we won't have to wait forever to get one.

Does It Matter?

One final thought. One way to "integrate" programs is not to bother: do you really care whether your program has been interrupted and remains resident in memory as opposed to saving your work on disk, calling in a new program, and reinvoking the original when it's wanted again? Or that in order to transfer data from one program to another, you must go through a disk file? Of course, we do care when disk access is slow; but what if it were nearly instantaneous?

Indeed, that's pretty nearly what I do now. Despite the advanced machines available, I still do all my writing on Zeke II, a CompuPro Z80. This is partly sloth but mostly my attachment to my (alas, no longer available) Archive Hall-effect keyboard and my memory-mapped video brought out on an ancient but incredibly reliable Hitachi 14-inch monitor. (It was a 15-inch monitor when I bought it, but the measurement standards seem to have changed.) I suppose that some day I'll change to another system, but so far I've no overwhelming temptation to do so.

What makes this ancient system tolerable is a megabyte of RAM (random-access read/write memory) disk. Mine happens to be CompuPro's M-Drive/H, but I've also used Semi-Disk without noticeable difference. The result is that I can save this entire column in about 2 seconds. It takes about 20 seconds to save the column, exit the editor, and bring in my address book or a small database. I've also written filter programs that convert one kind of file to another, so

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that the output of one program can become the input for the next; by using the CP/M Submit utility I can do highly complex operations, and given the RAM disk they go fast. It's not integration or anything like it, and I do indeed miss the SideKick utilities; but the speed of the RAM disk takes a lot of the sting out of nonintegration.

The major problem with the RAM disk is that everything goes away during a power failure. However, memory isn't the only thing that's getting cheaper each year. So is the uninterruptible power supply (UPS); at COMDEX I saw more than one UPS that would be better than adequate to run Zeke II for half an hour or longer, plenty long enough to protect work in progress. There are still plenty of incentives for integration, but with a RAM disk and a UPS I can afford to sit back and wait until something really excellent comes along.

Poor What?

While we're on the subject of integration, there is a program called Write-Hand-Man (WHM) from Poor Person's Software. The name is a play on SideKick, of course. WHM attempts to do for CP/M 2.2 systems what SideKick does for the IBM PC. The problem is that CP/M systems are already hurting for available memory; using up another 6K to 8K bytes for a resident demon can present problems. WordStar doesn't particularly notice the loss, but WRITE and other text editors that work only on text resident in memory certainly do.

Another problem is the trigger character. Few CP/M keyboards can generate anything other than ASCII (American Standard Code for Information Interchange) characters 00 through 127, which means that only 32 control characters are available. Many of these, such as carriage return and horizontal tab, already have accepted meanings, leaving even fewer available characters to do special things, such as moving the cursor around. To use WHM, you must choose something your terminal can make that you won't normally use. Poor Person's Software suggests ASCII null (00), which is Control-@. Whatever you select can never be used for anything else while you're running WHM.

WHM gives you a notebook, a phone book, and a two-week appointment calendar. It also gives you the option of running any other program that you've written and assembled and left on the disk as a .REL file. If you want to write your own application programs, you'll need a relocating assembler like RMAC or M80. (If this means nothing to you, don't worry about it.)

WHM is ingenious and works as intended. The manual is only about eight pages long. Most of the information is more useful to hackers than to users. You have to read through all of it, then go back and start over, before you get all the information needed to install the program. Even so, I'd guess that all but the most naive users would be able to get WHM installed provided they don't mind making a few mistakes and doing some experimentation.

There was a time when I would eagerly have welcomed WHM; but, in fact, I've found that the loss of memory when I'm writing is too high a price to pay for the limited convenience. It's possible that I'm spoiled. I also have plenty of RAM disk.

Terminal Advice

A book I wish I'd had years ago is David Stephens's *A Programmer's Guide to Video Display Terminals* (Atlantis Publishing Company, POB 56967, Dallas, TX 75220). It's priced a bit high at $30, and it's hardly light reading; but if you need it, you need it bad.

The book is mostly tables of control codes. What sequence erases to end of line for the Teletype 5420 terminal? What homes the cursor? How do you clear the screen on the Ann Arbor Guru terminal? It's all here, page after page of information in readable form. Terminal manuals are notoriously poor, written by graduates of that secret school that teaches the black art of incomprehensible technical writing. This book tables the information in a sane and clear-cut way. It's even indexed several times in ways that bring together terminals with similar command structures.

You can also get the data in the book on disk; write Atlantis Publish-

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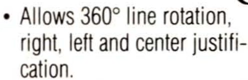


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ing for information. Anyone serious about writing install programs to put software on a variety of terminals can't afford to be without both book and disk. Highly recommended for programmers.

CHEAP GRAPHICS

Hackers are probably familiar with the public-domain program GRAF 1.0. For $35 (well, it says $29.95 + $5 shipping and handling), Dr. Donald Brittain, who wrote the original GRAF, will sell you GRAF 2.0, which does considerably more. The GRAF programs plot bar and line graphs on Epson and Epson-compatible printers if you have one for a Z80 CP/M machine. GRAF 2.0 needs a full 64K bytes of memory. Time was when those were serious limitations, but no longer. However, it won't work on the older CompuPro 8/16 or the Zenith Z-100, which both use an 8085 rather than a Z80 for their 8-bit processor. It seems to work fine with the new CompuPro 286 with the Z80 SPUZ slave board.

Printers supported include the Epson MX-80 with Graftrax, RX-80, and FX-80; the C.Itoh ProWriter (shades of the past!); and the Okidata with Plug 'n Play chips (but not unmodified Okidata). The version I have comes in the Kaypro 5¼-inch disk format; you can also get it on 8-inch IBM single-sided single-density disks. Specify printer and disk format when ordering (there's no install program).

Writing the above paragraph takes me back to the days when nothing was compatible with anything else, even though CP/M had become the standard operating system. Things are supposed to be much better now. I wonder.

Anyway, GRAF 2.0 is simple enough to use and produces charts and graphs that are good enough for academic reports and the like. Dot matrix is dot matrix, of course; this isn't going to be print-quality work. It's more than good enough for term papers though.

GRAF 2.0 has a lot of convenient features, such as automatic scaling and labeling of graph axes, disk storage of graphs, overlay capability, and ways to take data from other programs. The manual is well written. This is one of those programs that does a job well without fuss or bother. If you need line or bar graphs and don't want to spend much money, this is the program to get. Recommended.

BLINKERS

Thanks. After my tirade about the Texas Instruments Professional's blinking cursor, I received more than 50 letters with fixes for it. Some of them got pretty elaborate, with full-screen

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Listing 1: A *simple program to fix the TI Professional's blinking cursor.*

```
                                          ;CURSE.COM
CUR       SEGMENT                         ;THIS PROGRAM SETS THE CURSOR
          ORG       100H                  ;TO FULL NO BLINK AND CLEARS
          ASSUME    CS:CUR                ;THE SCREEN. CONVERT AS FOLLOWS
          MOV       AX,0100H              ;USING DEBUG:
          MOV       CX,000BH              ; 1) RENAME FILE TO .COM
          INT       49H                   ; 2) LOAD DEBUG WITH FILE
          MOV       0AH,13H               ; 3) AT—TYPE M 400 500 100
          INT       49H                   ; 4) MODIFY CX FOR SHORT LENGTH
          INT       20H                   ;    AT—TYPE RCX AT : TYPE 120
CUR       ENDS                            ; 5) ISSUE W THEN Q
          END
```

control capabilities.

Bruce Neild of Cheshire, Connecticut, sent in the simplest cursor fixer (see listing 1). It's not fancy, but bound into a start-up batch file it will make the cursor bearable. Mr. Neild reports that he's happy with his TI PC, but "One is hard-pressed to find advertisements in today's magazines that say they also have the TI PC format. Oh, well, it keeps one from frivolous software purchases."

We can hope that will change. TI does seem anxious to provide support for software developers, and as I reported last month, I'm impressed with the natural-language links. TI also has an artificial-intelligence-based decision-function generator I hope to report on Real Soon Now.

TRUE MADNESS

I've just spent one of the most frustrating hours of my life. I tried to get the new True BASIC to do something useful. I didn't succeed. My usual result was to get cryptic error messages that are not indexed in the manuals: ask for HELP; get the message "Can't help with that. Try HELP TOPICS."; type in HELP TOPICS; and again get the message "Can't help with that. Try HELP TOPICS."

My first experiment was to try a simple program:

```
10 FOR I = 1 TO 128
20 PRINT I, CHR$(I)

30 NEXT
40 END
```

The result of that was "Illegal line number."

The index shows that line numbers are covered in the reference manual, not in the tutorial. Turning to the reference manual, I see that line numbers are said to be optional; I also see an example of a program that uses line numbers beginning with 100. Could that be it? I changed my little program's line numbers to 110, 120, etc. Ran program. Got "Illegal line number" message. Tried HELP. Got "Can't help with that. Try HELP TOPICS." This was not a message I particularly wanted.

At this point I was in zugzwang, because True BASIC has windows, but there is no obvious way to get from the command window to the editing window. The index isn't helpful on that, either. By fighting my way about—True BASIC uses function keys, but Control-C and the other things normal BASIC users are accustomed to do not do anything like what you expect—I managed finally to get some familiarity with the command system. For example, there is a way to get back to the command window: it's F2, the "history-window" key. The manual calls it a command window, but what the hell.

(continued)

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Once I sort of figured out how to use the editor—most of the commands aren't particularly intuitive—I edited my little program to have no line numbers at all. Press F9, which is RUN. It didn't run, of course. I got the error message "Ending doesn't match beginning." After a moment's thought, I made 30 (well, the statement that used to be 30) read NEXT I. That ran. Then I tried inserting some REMARK statements. They stopped the program. Try HELP. Couldn't help with that. Found out that True BASIC wants REM as the REMARK command. Incidentally, True BASIC doesn't recognize "?" as a synonym for PRINT. Anyway, I edited my REMARK to a REM statement. Tried running the program. This stopped at the END statement with the message "Ending doesn't match beginning." No amount of spelunking in the indexes of the two manuals produced information useful in fixing the problem. Eventually I had to go to command level, type NEW, and begin all over again.

In other words, it doesn't matter whether or not you're familiar with BASIC on microcomputer systems; if you want to use True BASIC, you'll have to read, *systematically*, through the entire terminally chatty manual. Don't skip. Some important points are buried in casual paragraphs. Even then you won't discover everything, and some things it tells you aren't true. I never did find an explanation of why my END statement to a simple program produced "Ending doesn't match beginning."

I may have a broken version, but I don't think I do; once I figure out the syntax, the programs seem to run all right (except for line numbers, which I can't get it to accept at all). Broken or not, the editing features don't all work. The manual says that Backspace at a line marker will delete the line, but, in fact, I have found absolutely no way to delete lines. (I can delete all the text in a line with either Escape, to delete from cursor to line start, or Control-End, to delete from cursor to end of line; but the blank line marker remains no matter what I do. Goofy.) The manual says that the Delete key works. Mine doesn't, on either an IBM PC or a Zenith Z-160. The index is off by a page or so on most topics, too. You don't expect that sort of error in an Addison-Wesley publication.

True BASIC has about as dumb a licensing agreement as I've ever seen. The Addison-Wesley lawyers couldn't figure out whether they wanted to protect their product—product is a pretty apt name for this thing—by copyright law, contract law, or trade secret law; so they tried for all three. The resulting schizophrenia would be hilarious if they weren't so serious about it.

If you get True BASIC, be warned:

(continued)

in the unlikely event that you'd want to, you are not allowed to "reverse engineer, decompile, or disassemble the Software."

These are minor nits. The real question is: why do we need True BASIC at all?

True BASIC doesn't seem to do anything regular BASIC doesn't do, and what it does do isn't attacked in a logical or intuitive manner. Escape to delete to end of line? REM but never REMARK? And the most annoying misfeature of all: True BASIC produces no output at all if it encounters an error! If, for instance, you don't have an END statement, when you try to run the program, True BASIC thinks to itself for a while, produces no output at all, and finally the cursor appears at the end of the program with the message "No END statement." If you have syntax errors, the same thing happens. No output. Only error messages. No more hacking through by inserting print statements as diagnostics. True BASIC compiles to an intermediate code, similar to the public-domain EBASIC and the earliest versions of CBASIC. It then interprets the intermediate code line by line. The result is that it's not as fast as truly compiled code, yet you don't have the convenience of line-by-line interpretation when writing code.

There are vast differences between True BASIC and what we microcomputer people have learned. They're supposed to be features. After all, True BASIC conforms to the standards set by the American National Standards Institute (ANSI), and indeed the Addison-Wesley press release proclaims rather proudly that True BASIC is the *only* microcomputer BASIC to be "true" to the ANSI standard. Why a standards institute would set standards so at variance with the versions of BASIC that microcomputer people really *use* is not known to me. I don't even know whom ANSI consults when they decide to set "standards." They sure didn't talk to anyone I know. Maybe they spent all their time with mini and mainframe people.

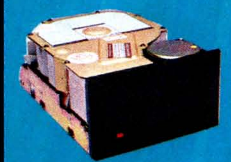
What I do know is that Microsoft BASIC is the microcomputer user's standard BASIC. If it hadn't been for Bill Gates and his early BASIC, there probably wouldn't have been a microcomputer user movement. Microcomputers might have been captured by the academicians and high priests, and we'd have no choice but to live with their "standards"; but that didn't happen. Microsoft BASIC and BASCOM are a powerful package. Alternatively, there's compiled CBASIC. Why learn yet another?

True BASIC has a few interesting features. There are MAT (matrix) operations; but since they're limited to add, subtract, and multiply, you'll have to write matrix-manipulation procedures before you can do any serious work with matrices. If you must write the more complex ones, it's no work to write the simple ones that come with True BASIC. Still, True BASIC does have MAT commands. Also, the graphics capabilities are good (or at least the manual says they are; I got tired of fighting with True BASIC's "features" after a couple of hours).

According to the press release, the real attraction of True BASIC is its ability to do structured code. There are special features for this. All very well, but I don't see any control commands in True BASIC that we don't have in extended BASIC for microcomputers. In the old days of little machines with small memories, often without disk drives, there was a flurry of tiny BASICs and small, limited interpreters. There had to be; our early machines wouldn't run anything larger. Those were days when dialects of BASIC multiplied, and BASIC programs weren't transportable. Now, though, it's rare to find a BASIC that isn't an extended, disk version. BASIC programs aren't totally portable, but I've found that conversion is general-

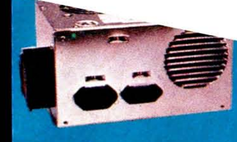
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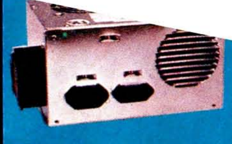


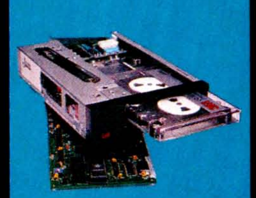


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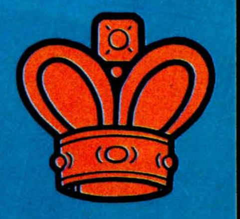




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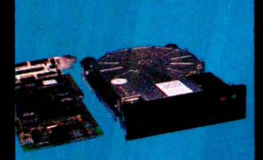
Internal - $865
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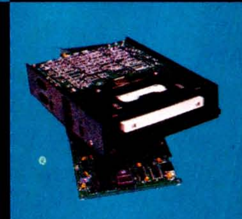


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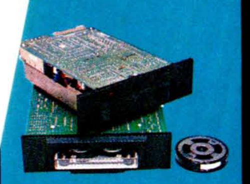
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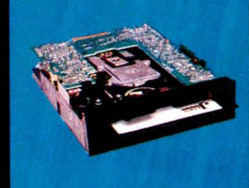
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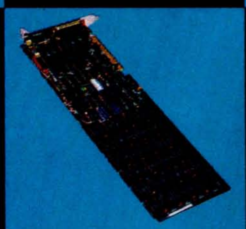
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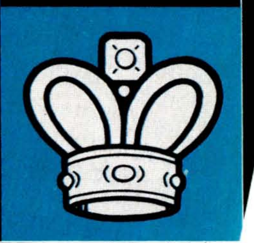
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ly pretty simple. As an example, it took me less than an afternoon to translate Jay Forrester's World Dynamics model into Microsoft BASIC.

The fact is that all modern microcomputer BASICs have IF. . . THEN. . . ELSE, WHILE, multiline functions, declarations, and a form of CASE statement. My mad friend used to hate BASIC because it made top-down code structures impossible; but before he died, even MacLean admitted that modern microcomputer BASICs were plenty good enough. He muttered that Microsoft had extended the language to the point that it wasn't really BASIC any longer; but he quit complaining about command structure.

True BASIC offers little that we don't already have (except matrix operations), but it does do things differently from the way microcomputer people have learned them. For example: there's a method for making variables truly local, which is no bad thing. True BASIC's method is similar to the method used by CBASIC—but with an important difference. In True BASIC, in order to have true local variables you must define your functions *outside* the program, after the program END statement. (Like CBASIC, True BASIC has no procedures, but functions can do just about everything a Pascal procedure can do.) I fail to see how this is superior to the CBASIC method: in CBASIC, variables declared inside a function definition are local to the function, and those declared outside it (or not declared at all) are global; what could be simpler? I suppose it's a matter of preference, but I prefer my functions to be inside my program; and if I'm going to use a compiled BASIC, I want one that compiles to native code, not to some intermediate code that it then interprets. It's probably all prejudice on my part.

BASIC was written 20 years ago by John Kemeny and Thomas Kurtz, the authors of True BASIC. Surely they ought to know what BASIC should look like? Moreover, Dr. Thomas Kurtz chairs the Dartmouth Graduate Program in Computer and Information Sciences and heads the ANSI committee on standards for BASIC. Perhaps that tells us something about the motivation of the standards committee? In any event, we can see what its chairman thought.

In the introduction to True BASIC, Kemeny and Kurtz say, "Today's personal computers are large and powerful machines that allow the implementation of a full modern BASIC. Yet the versions most widely used are what are called in the trade 'Street BASIC'—a horrible dialect of a beautiful language. And since the authors of these languages violated the fundamental design principles of BASIC, 'Street BASIC' is heavily dependent on the hardware being used. The same BASIC program will not run on different personal computers; indeed, it typically does not run on two different models from the same manufacturer.

"The time has come to replace the obsolete and often ugly implementation of BASIC with a well-designed, modern version."

In other words, little microcomputer user, you're terribly sick and don't even know it. Don't worry, though. The high priests are coming to save you.

It's funny that so few of us microcomputer users understand how badly we need help or how ugly our BASIC has become. Now we have The Word. Kemeny and Kurtz have called for "a rebirth known as True BASIC."

Perhaps they'll get it. Me, I think I'll pass up the opportunity to become a born-again True BASIC believer. I enjoy my Microsoft and CBASIC heresies.

GATO!

Years ago as a graduate student I worked on a U.S. Navy research proj-

(continued)

At NEC, monitors and printers are not peripheral issues.

All too often, brand-name CPUs are "bundled" with mediocre peripherals — a practice that makes for profitable sales, but does nothing for the system's performance.

In Japan, where most computer peripherals are actually built, NEC is the largest personal computer company — by far. And NEC didn't make it to first place by offering second rate peripherals.

The monitors with the broadcast video heritage.

While dozens of companies market display monitors, only a handful possess the tube technology and manufacturing capability to actually *build* them. NEC is one of the few. In fact, NEC's complete line of color and monochrome monitors reflects the professional and broadcast video expertise that twice earned NEC Emmy Awards from the National Academy of Television Arts & Sciences.

Winning the printer race takes both speed and endurance.

Ask people who really know about printers, and they'll tell you that NEC builds the best. They may also point out that NEC builds printers for other computer companies. And if you ask them to choose one word to sum up what makes NEC printers stand out, it will probably be "reliable." This is why NEC has become the printer of choice for the most demanding installations.

So before you buy a peripheral from any name company, make sure the company puts more into the peripheral than just its name.



ect at the University of Washington. The principal investigator was Dr. Paul Horst, but our immediate superior was Dr. August Dvorak, professor of sociology, inventor of the Dvorak keyboard, and uncle of the columnist John Dvorak. Dr. Dvorak was a Naval Reserve captain and had been skipper of a Gato-class submarine in World War II.

I'd read *Run Silent, Run Deep* (and seen the movie), of course, but otherwise I knew nothing of submarines. When Dr. Dvorak was in a chatty mood, he tended to talk about his keyboard rather than telling war stories; but once in a while he'd spin a yarn. Submarine duty was pretty exciting in those days. I suppose it takes a special kind of sailor to go to sea in a ship *designed* to sink . . .

Anyway, that explains why I was interested when I saw a game simulation of World War II Gato-class submarine warfare.

My first reaction to Gato was dismay. When you start the game, things happen *fast*. "I'm a Star Fleet Admiral. I don't know anything about this wet Navy stuff," I protested, but it didn't do me any good. The enemy continued to move, and my ship was just sitting there. The enemy ships were moving *fast*.

Like many games of this type, Gato is a combination strategic and arcade game. You have to think up what to do while you're doing something else. This kind of game gives me mixed emotions. Compressing a four-hour battle into five minutes certainly puts you under considerable pressure, but it isn't very realistic. On the other hand, true realism would be boring; you don't want to spend hours on a single attack. I do wish I could slow the game down a bit. Even at the beginner level the action is a bit fast. You can stop the game for a while to plan things out, but if you do, you can't see any of the displays; as soon as you look at the chart, or your own speed and heading, or anything else, things start moving again. You get used to the command structure after a few plays, but it's still pretty hectic.

Don't get me wrong, though. I like the game. I must. I've certainly wasted enough time with it. The PC version is in color. The Macintosh version is more fun. Maybe I'm getting used to the Mac? Recommended.

Spring COMDEX

Spring COMDEX in Atlanta this year was a mixed bag. I didn't find much to write about, but I did see a number of items that look pretty good. I use COMDEX as an opportunity to meet people, see interesting items, and look for things to review later.

One long-awaited item was a big display of new Atari computers. They look pretty good for the price, but Atari isn't shipping them yet, and I long ago gave up being much impressed by items on a showroom bench. Also, it's difficult to see how there's going to be much software for them, since Atari was charging pretty stiff prices for early development-system copies of the machine. I'd have thought Atari would want to get a lot of those machines out in the hands of the hackers, but Atari's policy made venture capitalists out of the software developers.

Another hot item was the Zenith Advanced PC, an 80286-based IBM PC AT clone. (Alex promptly dubbed it the ZAT, a name that I suspect will stick despite all effort on Zenith's part.) I think I'm going to like the ZAT. I've been impressed with other Zenith equipment. We'll see when I get one here. By the time it comes, I ought to have the construction people out of my hair.

Read That Manuscript

One of the more interesting items at COMDEX was the Omni-Reader by Oberon. This is a gizmo into which you can insert a page of typescript,

(continued)



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then by drawing a mouse-like gadget across the paper line by line, get the text into machine-readable form. I wrote several books back before Ezekial, my friend who happened to be my first Z80, came into my life. It would be nice to get those books onto disk so they could be painlessly revised. The Omni-Reader looked like a godsend.

Alas, it's not quite that simple. The Omni-Reader accepts only certain typefaces. Fortunately, 12-pitch Letter Gothic from a Selectric is one of them, since that's what I wrote all my early books in. (I didn't then realize that it's better to use 10-pitch and save your editor's eyes than 12-pitch and save paper. Live and learn.) However, the Omni-Reader is a bit tricky. You have to move the reader across each line at a fairly constant speed; wait; try again if you went too fast; and in general deal with the text line by line. After a while it gets easier, because you get a feel for how fast to drag the reader and thus don't make as many mistakes.

After that it's faster than retyping. Not a *lot* faster, but enough so that it would probably be worth using to get my early books into machine-readable form—except that any editorial changes made in manuscript, and all rewrite in galley, would have to be entered by hand anyway. The Omni-Reader can't read the finished book because typesetters deliberately vary the spacing between characters, and this bothers the heck out of the Omni-Reader. By the time I've compared the typescript to the printed material, I've used up the time the Omni-Reader saved. Simpler to hire someone to type directly from the printed matter.

The result is that it's hard to see what to use the Omni-Reader for. One possibility would be in an office that has both typewriters and computers; letters written on a typewriter could later be read into the machine. I do wonder, though, if it wouldn't be better to write the letters on a computer to begin with. On the other hand, if you want to put letters that you've received from someone else into machine-readable form, Omni-Reader would save you considerable time.

There are versions of Omni-Reader for both Macintosh and PClones. The machine reads manuscripts written in Courier 10 and 12; Letter Gothic; and Prestige Elite. Oberon promises additional font selections on disk in the near future.

It's a neat gadget. I'm very fond of the concept. It's well made. It's just that it's not that much faster than retyping, and after the novelty wears off—say, after about five pages—not much more fun. The Omni-Reader works as advertised, and Oberon has been very careful not to make unjustified claims for it. It's a pity that

(continued)

someone hasn't developed an easy way to scan books. Oh, well.

If you have a need for an optical encoder that reads typescript line by line, then this one certainly does the job.

WINDING DOWN

I suppose one game of the month is Gato (although the boys continue to rise through the ranks in Cygnus's Star Fleet I). The other game of the month isn't really a game. That is, Blue Chip Software, makers of the neat stock-market game Tycoon, have a financial-planning simulation called Squire that can teach some valuable lessons about retirement funds, tax shelters, and the like. The version I have is for MS-DOS; I expect there is, or shortly will be, a Macintosh version as well. If you don't have a feel for compound interest and the effects of taxation on wealth accumulation, you owe it to yourself to get this one.

Two other interesting games for the IBM PC are Incunabula and By Fire and Sword, both from Avalon Hill. Both can be fun played solitaire but are really better if there are multiple players. Incunabula starts with clansmen struggling to build a civilization while avoiding destruction at the hands of nomads and raiders. Accumulate enough wealth and you can invest in various arcana such as architecture, mathematics, or music. By Fire and Sword is a game of medieval combined-arms armies, diplomacy, and treachery. Both of them snaffled off more of my time than I could afford.

The books of the month are *Stock Selection: Buying and Selling Stocks Using the IBM PC* by Jeremy C. Jenks and Robert W. Jenks (Wiley, 1984, $17.95, $67.90 with programs) and *The Serious Assembler* by Charles M. Crayne and Dian Girard (Baen Books, 1985). Fair warning: the latter book is a Pournelle Users Guide. It's also the best intermediate-level book on IBM PC assembly-language programming I've come across. If you're seriously thinking of doing such programming, look at this one. It has useful programs as examples. The Jenks book has a revealing discussion of the real world of Wall Street, as well as common sense on using computers and some good practical programs. Fair warning: if you buy the Jenks book and end up losing your shirt, it's not my fault.

With any luck, next month's column comes from my new office. I can dream, can't I? ■

ITEMS DISCUSSED

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INCUNABULA $30
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EXCEL (includes Apple's Switcher) $395
Microsoft
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POB 97200
Bellevue, WA 98009
(800) 426-9400

GATO .... Price unavailable
Spectrum HoloByte Inc.
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Boulder, CO 80302
(303) 433-0191

GRAF 2.0 .... $29.95
Microcomputer System Consultants
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MACINTOSH
128K bytes $2195
512K bytes $2795
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CHAOS MANOR MAIL

Editor's note: Due to space limitations, we are able to publish only a sampling of the great amount of mail Jerry receives each month.

WILL YOU STILL LOVE IT WHEN THE COMMODORE IS 64?

Dear Jerry,

I've been reading your column for several years. I'll agree wholeheartedly that anybody who writes every day needs a computer.

What I do question are your comments about "toy" computers. For what it's worth, I put out a 64-page quarterly magazine, a number of freelance articles a year, speeches, special pamphlets, and the equivalent of an average paperback book in other publications a year on a Commodore 64.

In fact, circulation, mailing lists, billing, payroll, bookkeeping, and a tournament record of about 500 competitors in 35 events is kept on the 64.

I've got a $50 word processor that keeps up with my writing gusts and has more formatting potential than most "professional" programs and can even be used with 80-column software. (I'd love faster disk speed, but what's 5 extra minutes a day waiting for a disk compared to tripling the price of the hardware and quadrupling the cost of software?)

What's more, we have three workstations (C-64s) with disk drives, two printers, and interchangeable software and files. Anytime machines are run 8 to 10 hours a day they may go down—so we have backups on line all the time. I can replace any component other than printers for less than $250.

Mouse technology? Icons? 80-column hardware and superfast disks? I'd love it. But I seriously question that it would be a significant enough increase in productivity to be as worthwhile as a printer buffer or two.

Yes, I think also that we're probably using the little Commodores to near potential. But until dollars justify changing and until Apples or Oranges or Big Blues can offer a better per-dollar value, we'll stick with what we have.

MILO DAILEY
Memphis, TN

I guess I both agree and disagree. It is possible to do productive work with primitive equipment, and indeed the worst computer system is likely to be better than the best nonelectronic typewriter. On the other hand, ballpoint pens are preferable to quill pens.

I can live without icons, but surely you do not mean that a writer will not be more productive when enduring less eyestrain? Or that writing time is less valuable than time spent waiting for disk access?

A penny saved is a penny earned; but those who save pennies seldom become wealthy. I'll bet you a fair amount that a few thousand spent on updating your equipment will make those three workstations as productive as six would be using what you have.

Stay well.—Jerry

TRANSFERRING FILES

Dear Jerry,

In reference to Mark E. Cornell's letter regarding use of the SAVE command to transfer files from the NEC PC-8201A ("NEC PC-8201A," February, page 359), I routinely use this command to transfer files from my NEC to an S-100 system running ASCOM. The form is SAVE COM:abcdef, where a is the data-transmission rate, b is the parity, etc. This method of transferring a BASIC program can save many minutes over the alternative of using Telcom.

The only trouble I have encountered was in transferring from the S-100 to the NEC at 19.2 kbps. In this case, I lose an occasional byte, even with XON/XOFF protocol.

I'm not sure what the source of the problem is for Mr. Cornell's application. Perhaps it is the form of the SAVE command that he used. I am not familiar with the one he gives in his letter. If the form I have given above still does not resolve the problem, I suggest that he check his cable grounds (pins 1 and 7) and make sure XON/XOFF protocol is activated on both the NEC and the Kaypro.

Incidentally, I give you an "F" on this one, Jerry—you didn't do your homework. The use of SAVE is documented in the NEC manual under SAVE and OPEN. Mr. Cornell's letter deserved a few minutes of your time to consult the manual and suggest some alternatives a bit more meaningful than your response of "Alas, I think you have no choice but to save your programs in ASCII and use Telcom."

CORT COOPER
Ponca City, OK

Guilty as charged, but with an explanation: as I said, I don't use Percy, our NEC PC-8201A, except for writing while on trips; so I've not had reason to investigate some of his other capabilities.

Thanks.—Jerry

KEYBOARDS

Dear Jerry,

In reading your columns, which I enjoy greatly, I get the impression that you are not altogether satisfied with the IBM keyboard but that you are reluctant to switch to the Key Tronic 5151, despite its superior layout, because you dislike the light feel.

My 5151 was shipped with 1.5-ounce springs in the keys, although I have been told by the manufacturer that they have since switched to 2-ounce springs. In any event, it was a simple matter to remove the light springs and install a new set of 3-ounce springs supplied by the manufacturer, along with a tool for removing them.

As a result, the 5151 has an altogether different feel, much more like the IBM. As a professional writer, I can attest that the change has given me the best of both worlds.

ANDREW J. GLASS
Washington, DC

I'm glad to hear that Key Tronic has made some improvements. It turns out that I wasn't the only one who found that the original 5151 had a "dead" feeling.

Alas, for the moment the Wico Smartline Smartboard keyboard has made the question moot. Beyond the Wico is a new keyboard under development by Texas Instruments; if the production model is anywhere near as good as the prototype I've seen, nothing will be able to touch it. Of course, Key Tronic isn't going to sit still either.

Best.—Jerry ■

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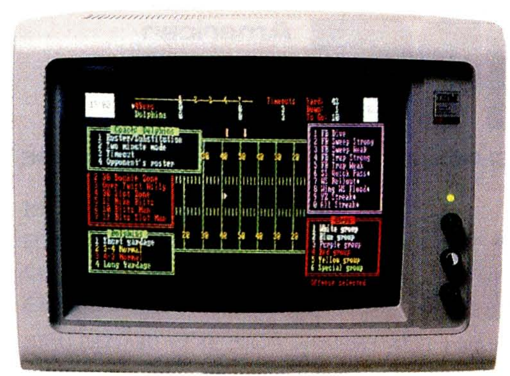
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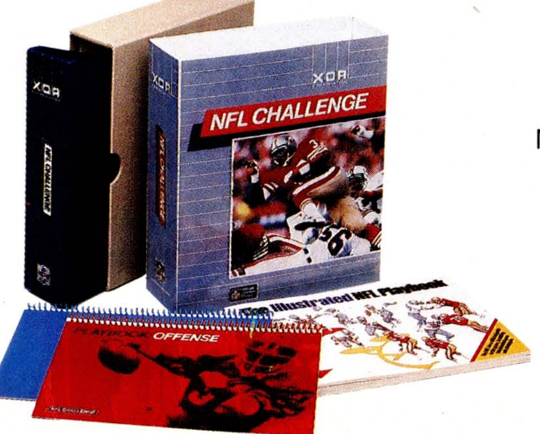
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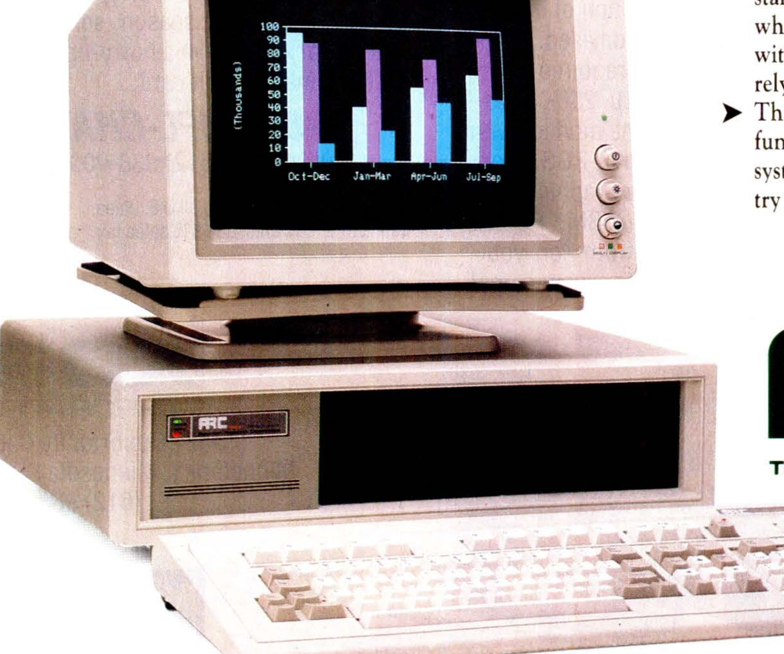


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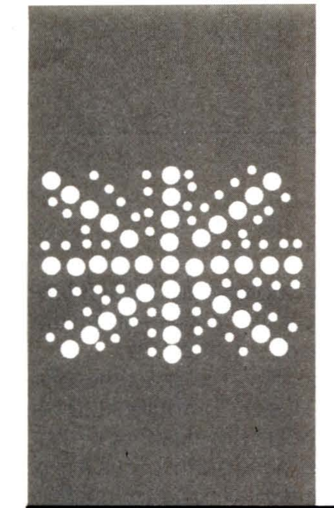
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Seventh Anniversary of Microcomputing

A brief history of U.K. computing and a look at the Husky Hunter

BY DICK POUNTAIN

This being the 10th anniversary issue of BYTE, I have been asked to offer a condensed history of personal computing in Britain.

I became involved with computers in 1977 when a friend, who was a mathematics teacher, told me that he'd just seen a demonstration of a "personal computer" (the Commodore PET) that fit on the top of a desk. I recall asking him "Why would anyone want a computer?" The answer became obvious to me a short while later when I purchased a programmable calculator (a Casio fx-201p) to help with print-costing computations. Within weeks I was addicted to programming, on a device with 127 bytes of memory and no editing facilities. I even wrote games for it.

Personal computing started in the U.K. about three years behind the U.S., so, strictly speaking, we can celebrate only our seventh anniversary. U.S. personal computers began to arrive in Britain in 1977, but those first machines (Altair, South West Technical Products, and Sol) were just too expensive to create a hobbyist following.

In 1978 the PET, the Apple II, the TRS-80 Model 1, and the Exidy Sorcerer arrived, but at £500 and upward, they were still too expensive for the average hobbyist. Their entry prices had profound significance, though. At over £1000 the Apple II was so expensive that the cheaper, all-in-one PET became the dominant machine in Britain, Germany, and Scandinavia, keeping Commodore comfortably afloat during those lean years when Apple was cleaning up in the U.S.

The real pioneers of personal computing in the U.K. needed something much cheaper. The U.K. computer industry was born in the form of kit computers, such as the Nascom 1, the Science of Cambridge Mk 14, and later the UK101, which sold for £200 and under. They were single-boards, with typically 2K to 4K bytes of RAM (random-access read/write memory), a hexadecimal keypad (the Nascom's ASCII [American Standard Code for Information Interchange] keyboard was quite a luxury), and a machine-code monitor in ROM (read-only memory). Having built the kit, you then had to write the system software—starting with an assembler if you were feeling lazy.

To service those intrepid hackers, the first U.K. personal computing magazine, *Personal Computer World*, was published in 1978.

The first packaged U.K. home computers, the Acorn Atom and the Sinclair ZX80, arrived in 1980. Both were offered in kit or prebuilt form, had BASIC in ROM, and introduced a second generation of slightly less crazed hackers to computing.

The Atom was a 6502-based machine with 2K bytes of memory, expandable to 12K bytes, and monochrome output to a television set including "high-resolution" graphics. It grew out of a system of single-board modular computers that had launched Acorn into the industrial-controller market the previous year. The Atom's success put Acorn on the road to the BBC Micro.

Sinclair Research and its founder, Clive Sinclair (now *Sir* Clive Sinclair), were already known for dramatic interventions in the low-cost consumer-electronics market. Earlier products had included a £25 programmable calculator (when everyone else charged over £100), the infamous Black Watch digital-watch kits, and a range of miniature hi-fi equipment produced 15 years before the Japanese got there.

To the ZX80 fell the honor of breaking the magic £100 price barrier. This tiny sliver of white plastic contained a Z80 with 1K byte of RAM, integer BASIC, and television and cassette interfaces, and it hinted at the era of mass-market computers. A year later it was replaced by the ZX81 with floating-point BASIC and an astonishing price of just £70, or £50 if you wanted to solder it yourself. Inside the ZX81 were just 4 chips compared to 21 in the ZX80; the uncommitted logic array had arrived in the home.

(continued)

Dick Pountain is a technical author and software consultant living in London, England. He can be contacted c/o BYTE, POB 372, Hancock, NH 03449.

This machine is designed to keep all data and programs in nonvolatile CMOS RAM *and to download to a desk computer back at "base camp."*

Another year later Sinclair followed up with the 48K-byte color Spectrum at £125 and proceeded to multimillionairedom. The Spectrum (marketed for a while in the U.S. as the Timex Sinclair 2000) still dominates the games-playing home market in the U.K., with hundreds of thousands of sales. Only recently has the Commodore 64 come close to challenging it in sales and volume of software.

Meanwhile Acorn produced the BBC Micro to the BBC's (British Broadcasting Company's) specifications for a computer that could be used in conjunction with an educational television series. (The competition for that BBC contract had been bitter.) The BBC Micro, with its fast 2-MHz 6502 and fine color graphics, quickly became established as a favorite school and college computer. Despite its high price, it also became the machine that serious hobbyists aspired to, filling the slot left open by Apple's relative marketing failure in the U.K.

Unfortunately, Acorn rode that basic design too long. Announced enhancements were continually delayed, resulting in Acorn's near collapse and rescue in March of this year by Olivetti.

Another prominent U.K. manufacturer, ACT, started by selling PET software and importing the CompuThink Minimax CP/M machine. ACT then took the wind out of IBM's European sales by importing Chuck Peddle's Victor 9000 as the ACT Sirius, and now manufactures and markets the Apricot range of microcomputers with considerable success.

The threatened Japanese invasion never quite happened in the U.K., though Sharp made some impact here in the early 1980s with its PET competitor, the MZ-80K. I did all my serious learning on a Sharp MZ-80B running CP/M 2.2; after all those quirky home computers with their proprietary operating systems (often incompatible between versions), it was a real liberation. Suddenly compilers for all the interesting languages (except Smalltalk) were within reach.

It seems only right to pay tribute to some of those who fell by the wayside. Quite a few interesting and some downright cranky machines have come and gone in our seven years of personal computing. There was the Newbrain, half the size of an NEC lap-held computer, with its built-in display and battery pack that never quite arrived. With a very advanced specification for its time (Z80, indefinitely expandable RAM and ROM, graphics), it was to be the BBC Micro until production difficulties decreed otherwise.

Then there was the Jupiter Ace, a tiny ZX80 look-alike with a rubber keyboard and FORTH instead of BASIC in ROM. The fact that FORTH is not a beginner's language killed it, though it still has its fans and bankrupt stock still surfaces occasionally for about £30.

There was the Dragon 32 with its estimable 6809 processor and an upgrade path to the OS-9 operating system. It was the best value for the money for six months in 1982. What about the Oric, whose very name was an invitation to prepare the headline "Alas, poor Oric . . ."? It became the most popular home microcomputer in France. And there was the Lynx, remembered chiefly as the first computer whose BASIC had floating-point line numbers.

Indestructible Computing

This condensed history of U.K. personal computing leads me rather nicely into my next topic. It is probably not well known that the first lap-held computer was made—and is indeed still made—in the U.K.

The reason that the machine, the Husky from Husky Computers Ltd., is not more widely known is that it's not aimed at the mass market. It is a *ruggedized* computer intended for military or outdoor scientific and engineering uses. It made quite an impression (literally) when Husky's representative hurled a Husky Hunter onto my floor to demonstrate its tolerance of abuse; I doubt that a Tandy or an NEC would appreciate such treatment.

The first Husky was manufactured in 1981 and captured some attention by virtue of the press photos of it being run over by an Army truck. Since then the design has been refined and diversified, though the basic elements remain the same. It is available in the U.S. from Sarasota Automation Inc. (1500 North Washington Blvd., Sarasota, FL 33577).

The Husky is driven by a CMOS (complementary metal-oxide semiconductor) Z80-compatible chip, the National Semiconductor C800, clocked at 4 MHz, and uses the CP/M operating system.

Husky's designer made a very important decision right from the beginning. For use in rough or hazardous environments, no mechanical mass-storage device is sufficiently robust or reliable. This machine is designed to keep all data and programs in nonvolatile CMOS RAM and to download to a desk computer back at "base camp" using a built-in serial link.

This decision required the provision of plenty of RAM; from the first, the Huskies had a paged-memory system of 144K bytes. In 1981 memory was considerably more expensive than it is now, and this guaranteed a high unit cost of over £1000.

Users who needed a machine of the Husky's ruggedized quality were not deterred by the price, and the orders rolled in from day one. Users include regional water authorities (for on-site reservoir-volume calculations), the Greater London Council (for welfare-benefit calculations), various airlines,

(continued)

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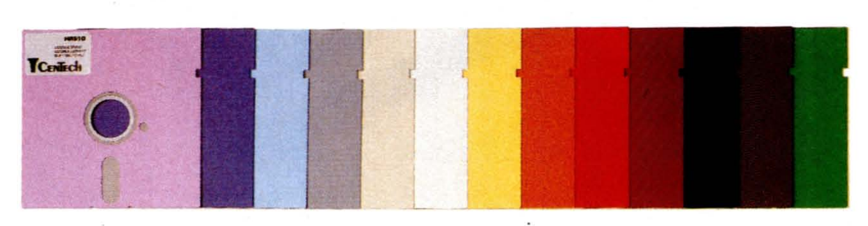
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HUSKY HUNTER

The latest model, which I borrowed for this article, is called the Husky Hunter (see photo 1).

The first feature you notice is its size; it's almost exactly half the size of a conventional A4-size lap-held microcomputer. This small format precludes the use of a full-size typewriter keyboard, so the Hunter is not a machine for portable word processing. Instead it has a calculator-style button keyboard, with an undersize, noncentral space bar.

The second thing you notice is its construction. Like all Huskies, the Hunter has a cast light-alloy casing of a thickness that would not be out of place in a hand grenade; the computer, nevertheless, weighs only 1.2 kilograms and can be easily held in one hand. The removable bottom of the case is secured by 12 recessed Allen bolts and sealed with a rubber gasket, which makes the whole thing watertight.

While Husky does not recommend that you use the Hunter underwater, it will certainly stand up to being accidentally dropped into a tropical torrent. Another feature is an internal humidity indicator in the corner of the display. This warns you if moisture enters the case, which is normally kept dry by silica gel.

The battery compartment holds four AA penlight batteries (good for 50 hours) and is capped by a huge alloy screw plug with another rubber gasket. The removable batteries are backed up by an internal rechargeable battery that protects stored data in the event of a low-battery condition occurring in the field. The manual warns that power loss could be experienced in the proximity of "nuclear events," but I feel that damage to the "warmware" would concern me more in such circumstances.



Photo 1: *The Husky Hunter.*

Since the Hunter's case is hermetically sealed, Husky gives instructions for releasing over- or underpressure conditions, for instance, if you're in orbit, or in a diving bell, by momentarily loosening the battery plug.

A sturdy wrist strap for carrying the Hunter attaches to either side of the case by a swivel mounting. The case is not perforated by the various I/O (input/output) connectors found on ordinary computers. A single 25-pin male "D" connector for the serial link is recessed and sealed into the otherwise unbroken metal surface.

The 40-character by 8-line LCD (liquid-crystal display) lies beneath a flush plastic window that appears to be more than ¼ inch thick. The viewing angle can be adjusted from the keyboard, thus eliminating another source of holes in the case. This display provides a window onto a virtual 80-character by 24-line standard CP/M screen, but it can also present 240- by 64-dot high-resolution graphics from BASIC.

The Hunter contains 48K bytes of ROM firmware, including a text editor, communications program, BASIC interpreter, and the file manager DEMOS, which is fully compatible with CP/M 2.2 but works from a RAM-disk emulator instead of a floppy disk.

You select the ROM programs from the menu presented when you turn on the computer by pressing the number keys in conjunction with a function-shift key. The bottom line of the display shows you the function-key assignments. Ordinary CP/M programs are run from a ">" prompt as usual.

A 54K-byte transient program area is supported for CP/M programs, with the rest of the memory, up to 208K bytes, devoted in 48K-byte pages to virtual disk-file storage.

The BASIC, which looks much like a very extended Microsoft version 5, does *not* run under CP/M and therefore has the entire 54K bytes free for programs. It does, however, use the same file store as CP/M programs.

The text editor is a full-screen editor

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with simple functions such as FIND—quite adequate for small documents, though the keyboard militates against touch-typing.

Both file-transfer and asynchronous terminal programs are included and can be operated at up to 4800 bits per second. A special disk program is available to transfer data to and from an IBM PC or a Sirius/Victor. A permanent clock/calendar is included, offering a typical accuracy within two seconds per day.

I found operating the Hunter to be just like using a full-size CP/M machine with a single drive. It ran standard dBASE II satisfactorily. The keyboard takes some getting used to because it is small and requires very positive keypressing to work. The LCD quality is neither better nor worse than that on the Tandy Model 100.

Husky supplied me with a sample of a real application program that had been developed in BASIC for an overseas airline. It acts as a portable cash register for in-flight refreshment sales, with the unusual twist that it can accept payment in a mixture of different currencies. The Hunter has an autorun feature that lets you set up such programs as turnkey applications. You can use the function keys to avoid typing commands on the small keyboard; 16 such functions are available.

Special Huskies

In addition to the Hunter, Husky manufactures several special-purpose variants based on the same architecture. Each of these is packaged in a somewhat larger case (still of thick cast alloy) with a membrane keyboard for complete sealing and lack of moving parts. Husky has discovered that such membrane keyboards are easier to operate when wearing protective gloves.

The Husky SP (Special Performance) has a larger memory (352K bytes) and twice the battery life of the Hunter. It's intended mainly for running expert-system programs with large RAM requirements.

The Husky IS (Intrinsically Safe) is certified to meet the stringent standards for electrical safety laid down in the U.K. for the petrochemical, gas, oil, and mining industries. It uses the RS-422 interface for serial communication, with lower voltages—hence less spark risk—than the RS-232C.

The Husky A/D (Analog/Digital) has eight channels of A/D conversion built in and is intended for data logging at remote sites. It also features auto-answer modem handling so that you can interrogate and control it over a telephone line.

The military-specification Husky M-208 claims to be the first general-purpose computer in the world to meet DEF-STAN 66-31/1 and 07-55 standards for resistance to vibration,

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Competitive distance becomes parsecs with the BDS *open architecture*. One of the optional font cartridges allows custom or user-defined typefonts to be downloaded from the host computer. Which ought to create a brisk third-party business for suppliers of corporate logos, bar codes and special-purpose character sets.

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shock, and temperature, and its appearance suggests that it might be the only object to survive World War III. It uses a military-standard 19-way bayonet socket for serial communication; the British Army uses it to test guided-weapon systems in the field.

Although Husky emphasizes the use of RAM storage in the field, the company supplies both a disk drive and a digital-tape data recorder for backup and archiving data from the computers. The disk unit uses 3-inch floppy disks.

SUMMARY

The Husky Hunter makes every other computer that I've handled feel quite flimsy. It isn't suitable for word processing, but is intended to run CP/M applications in outdoor or other hazardous environments that could quickly destroy a conventional plastic lap-held portable.

Huskies are not really computers for the office-bound. They go better with travel-stained jungle boots and a tin of mosquito repellent. Nevertheless, it amuses me to think that it might someday become chic to saunter around with a khaki M-208 on a shoulder strap.

In short, the Husky computers are serious tools; not everyone needs one, but if you do, you really need one. ■

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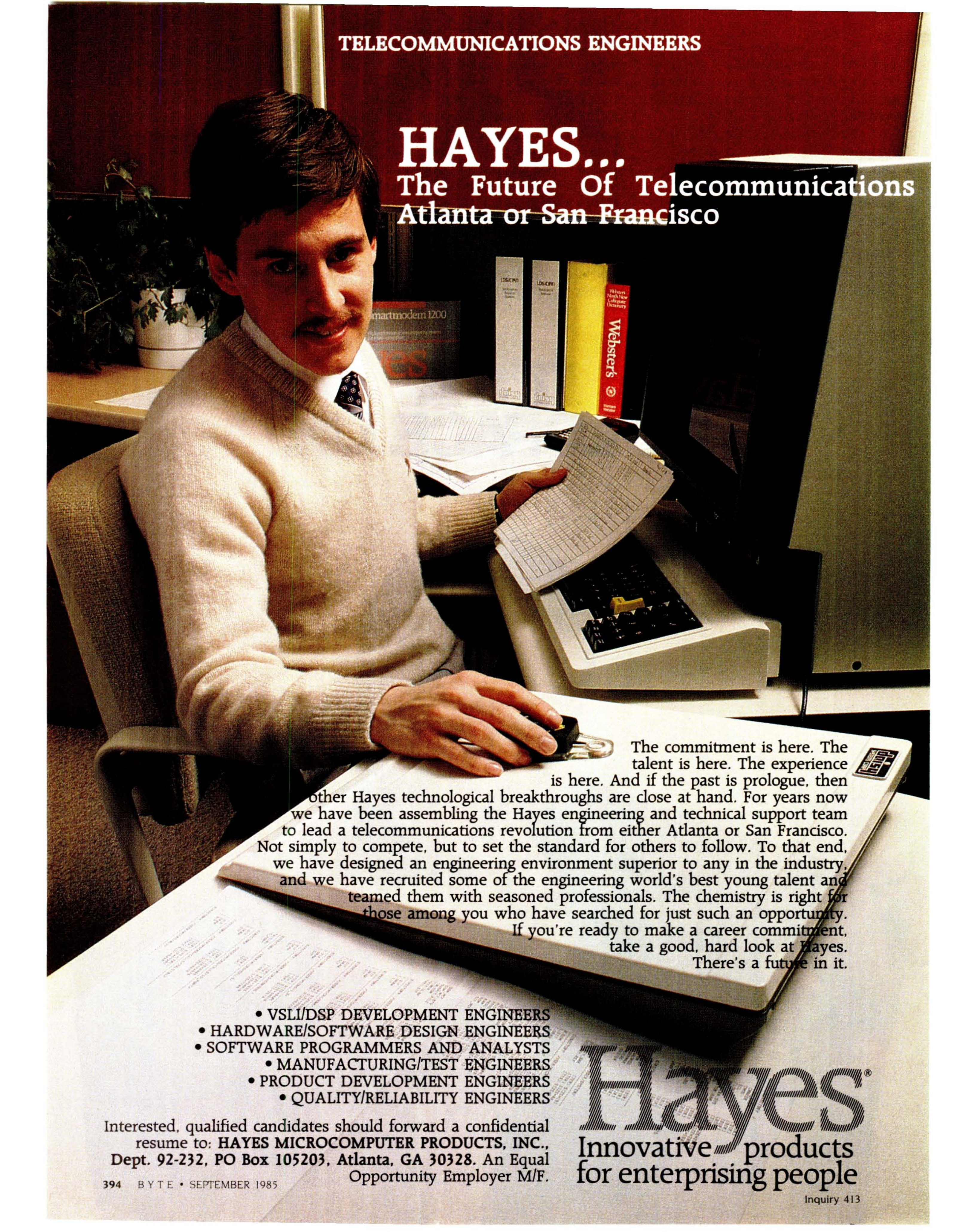
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A History of Japan's Microcomputers

TLCS-12
μCOM-4, -8, & -16
NEC 700
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And a new idea: A software vending machine

BY WILLIAM M. RAIKE

When Gregg Williams, a senior technical editor at BYTE, mentioned that the September BYTE was going to be the 10th anniversary issue and suggested that I devote this column to the history of microcomputers in Japan, my first reaction was "Great idea!" My next thought was "Where on earth can I find any information about that?" Luckily, thanks to Asao Ishizuka at BYTE's Japanese-language sister publication, *Nikkei BYTE*, I located a gold mine of computer-related reference material. It's a small, out-of-the-way library in Tokyo's Gotanda district that's operated as a public service by the Fujitsu people. Besides having all kinds of technical books and catalogs, the periodical files yielded just what I was looking for.

You can trace the ancestry of most of today's personal computers back to Intel's original 4-bit microprocessor, the 4004, which first appeared in November 1971. Intel's 8-bit 8008 microprocessor appeared the next year, followed by the landmark 8080 in 1973. In 1975, Zilog introduced the Z80, still in use today.

It didn't take the Japanese long to develop their own microprocessors. Toshiba developed Japan's first microprocessor chip, the TLCS-12. Announced in May 1973, only a year and a half after the Intel 4004 appeared in the U.S., the TLCS-12 was a 12-bit microprocessor that was intended primarily for industrial control applications. OEM (original equipment manufacturer) samples of the TLCS-12, including a circuit board in kit form, cost well over a thousand dollars. NEC announced its μCOM-4 in September 1973, followed in late 1974 by the 8-bit μCOM-8 and the 16-bit μCOM-16. If you really want to be picky, though, you can call 1972 the year of the first Japanese microprocessor; in the spring of 1972 NEC started shipping its NEC 700 series to Japanese manufacturers. Although the 700 series consisted of a set of two special-purpose LSI (large-scale integration) chips instead of a one-chip microprocessor, the two chips together were functionally equivalent to the Intel 4004.

Although other Japanese manufacturers introduced microprocessors of their own in the mid-1970s, NEC has consistently led the way in Japanese microcomputer technology. It started an intensive VLSI (very-large-scale integration) research program in 1975. In 1976, responding to the MITS Altair kit that appeared in the U.S. the previous year, NEC introduced a microcomputer kit for Japanese hobbyists, the TK-80.

In the late 1970s, as interest in microcomputers continued to grow everywhere, hobbyist-oriented microcomputer shows began to appear. In 1977 in Tokyo, 36 companies participated in what was apparently Japan's first microcomputer show. Although the featured products were mostly kits, chips, memories, interface boards, and the like, 35,000 people attended the show. During the same period, office computers began to appear at business shows, along with peripheral equipment like printers that could print Japanese characters.

Meanwhile, personal computers like the early TRS-80s, Apples, and PETs were being introduced in the U.S.—and marketed in Japan soon afterward. Predictably, after a lag of a year or two, the first Japanese personal computers appeared. In 1979 Sharp introduced the first machine in its MZ-80 series. Based on the Z80 processor, it was a single unit containing a keyboard, display, and cassette tape drive, and it came supplied with a version of BASIC. An external dual-floppy-disk-drive unit was available, but it cost about $1200 extra. The same year, NEC introduced its PC-8001, the computer that was to begin its dominance of the Japanese personal computer market. Despite competition from its own newer models, NEC has continued to modernize the design of the PC-8001 and recently introduced the PC-8001 Mk II SR, which is software-compatible with the original machine. The original PC-8001, like its newer

(continued)

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cousin, has a separate display. Most people use cassette tapes for external storage, but you can buy external disk drives. It can even run the CP/M operating system.

Both the Sharp and NEC machines came with versions of BASIC, like Hitachi's ill-fated (and glacially slow) BASIC Master series. They were sold mostly to technically oriented hobbyists, although games soon began to proliferate.

The Japanese-language display and processing capabilities of these early machines ranged from rudimentary to nonexistent. Perhaps mostly for that reason, the explosive growth in applications software that took place in the U.S. in the early 1980s didn't happen in Japan. Hobbyist-oriented hardware has continued to dominate the Japanese personal computer scene. In the last two or three years the availability of fast, powerful, cheap hardware with extensive Japanese-language capability has begun to change that, and competition is now mushrooming in Japanese-language applications software. Some of it is homegrown and some, like dBASE II, Multiplan, SuperCalc, and others, is imported under license with Japanese-language features added.

I think that the most important aspect of Japanese microcomputer history is what *didn't* happen here in the early 1980s. As regular readers of BYTE Japan know, the powerful influence of the IBM Personal Computer (PC) and compatibles on the U.S. personal computer market has been absent in Japan. Although NEC is the leader in Japanese personal computers, largely as a result of the PC-9801 series, its leadership is not undisputed, and competitors choose to compete technologically rather than to imitate like the IBM PC clones—apologies to Apple and the Mac. There are two sides to this coin: The lack of hardware standardization makes it tougher for software vendors to develop third-party application-software packages (although computer manufacturers sometimes offer inducements to cooperating vendors), but, at the same time, consumers get the chance to buy much more powerful and up-to-date hardware at very low prices. When I visit the U.S., people are impressed when they hear, for example, that Japanese users can buy computers (such as the latest NEC or Fujitsu machines) that run two to four times faster than the IBM PC. These computers are based on the 8086-2 or 80186 microprocessors, have a half-megabyte of RAM (random-access read/write memory) and a couple of 1-megabyte floppy-disk drives, run MS-DOS or CP/M-86, support the full Japanese language, have impressive color graphics capabilities, and are available for about $1300. A built-

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in 10-megabyte hard-disk drive brings the price up to about $2400.

Oh, Brother—A Software Vending Machine

Brother Industries makes some really neat products. My little EP-44 portable electronic typewriter/serial printer has worked perfectly since the day I bought it, and the newest model, the WP-600 portable word processor I wrote about last month, promises to be even better. This month I walked into the showroom lobby of Brother's headquarters in the Kyobashi district of Tokyo, near the Ginza, to get a look at Brother's latest brainchild, the SV-2000 Software Vending System. Brother has no plans to export it, but I think it's the most intriguing software marketing idea I've seen in a long time.

Made of molded white plastic, the SV-2000 Software Vending System looks like a telephone booth without sides.

In Japan, when you want to buy a new computer game, you go to a computer-software store that has rack after rack displaying hundreds of cassettes and floppy disks, just like a record store. The stores have no way to demonstrate most of the games, and new games are being published constantly. Word of mouth and magazine reviews can popularize only a few products, so buying new games can be an expensive gamble, even apart from the risk that the media you buy (the tapes or disks) might be defective.

Brother has come up with its SV-2000 Software Vending System as a new marketing approach. Made of molded white plastic, the SV-2000 looks like a telephone booth that has only a front, a back, a ceiling, and a floor—no sides. It reminds me of one of those arcade-type race-car driving games, except that you sort of slouch/stand against the back of the booth. The front of the booth has a display screen, a Start button, two cursor buttons, a Confirm button, a Cancel button, and slots for inserting coins, tape cassettes, floppy disks, and credit cards, as well as a printer slot. The booth works like a terminal: It's connected via telephone lines to a mainframe computer located somewhere else. The remote system controls the

interaction with the user, handles the financial transaction, and downloads selected software from its database onto the user's own tape or floppy disk inserted into the appropriate slot; the media (blank tapes or disks) are not sold through the SV-2000.

After pressing the Start button, a menu display asks you to specify which type of computer you own; you select a game from the next menu. Right now, the system covers only a handful of the NEC personal computer models. I would have thought it worthwhile to provide for the MSX computer family, in which there are dozens of models, all compatible with each other. Presumably, if the system is successful, Brother will extend it to additional types of computers.

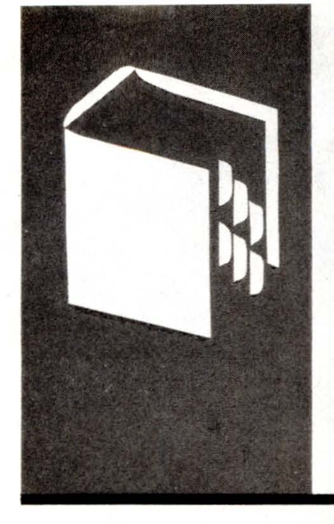
After you pick a game, using the cursor buttons to select a title from the menu, the SV-2000 displays a demonstration screen from the appropriate game to give you some idea of what the game is all about. If you want to buy the game, you press the Confirm button and follow the instructions for depositing money or a credit card and inserting your blank tape or disk into the appropriate slot. The SV-2000 prints the appropriate information onto a blank label you insert into the printer slot and then downloads the game onto your tape or disk. Typically, it takes about 3 minutes to download the software.

After you pick a game, the SV-2000 displays a demonstration screen to give you some idea of what the game is all about.

So far, the only SV-2000 booths in existence are the ones in the Brother headquarters in Tokyo and in Nagoya, but since the booth is so compact and plugs into an ordinary power outlet, Brother hopes to arrange with software manufacturers to install them in computer-software shops and in videotape and record stores. Brother expects the booths to cost somewhere between $8000 and $12,000 each.

Coming Up

Next month I'll tell you about the Tokyo Microcomputer Show, where I had a chance to see the NEC PC-98XA and PC-9801U2, the 286 XENIX System V, and a new Hitachi drive. ■



West Coast Faire, Mac Stuff, and the Amiga

BY BRUCE WEBSTER

This month's column will include some commentary and have less of a product-review emphasis. Trips out of town have kept me away from the computers. Also, the pipeline of hardware and software dried up for a while, leaving me with little to talk about. However, Brenda McLaughlin of BYTE's West Coast office has worked hard to fill up the pipeline again, and I now have enough to keep me busy for some time. Look for lots of products to be covered during the next few months.

West Coast Computer Faire

I went up to San Francisco for the Tenth West Coast Computer Faire, now run by Prentice-Hall. Jim Warren sold it to that company two years ago. The Faire is legendary for the number of major firms that got their start there. Apple and Digital Research are a few of them. A friend of mine delights in telling of an experience at one of the first Faires. He bought an early copy of CP/M (for $75) from a small booth staffed by Gary Kildall. (As far as I know, my friend still uses that version of CP/M on his IMSAI 8080.) This was my fourth Faire in a row, but it was my first as something other than an exhibitor, and I was looking forward to really enjoying it.

My impression after a day or so was that Warren sold out just in time. The Faire is shrinking. It may not be dying, but it is no longer the important trade show it was two short years ago. Without the giant booths from IBM, Apple, and AT&T, the Faire would have looked like any other small, local, end-user show. The move to the Moscone Center didn't help that impression; a large chunk of the main floor was unused, adding to the impression of the Faire's shrunken size.

Several reasons can be given for the Faire's diminishing stature, but they all sound like clichés: the rise of COMDEX, the invasion of microcomputers at NCC, the proliferation of specialized computer shows (like the Mac-World Expo), the maturing of the industry. A less-mentioned reason is that many exhibitors last year were outraged by high drayage fees (the cost to move goods and equipment on and off the exhibit floor) and hostile behavior from members of the labor force. I know of several exhibitors who swore that they would not come back this year, and they didn't. The result is the same: The Faire—and the industry—just aren't as much fun as they used to be, at least for those directly involved.

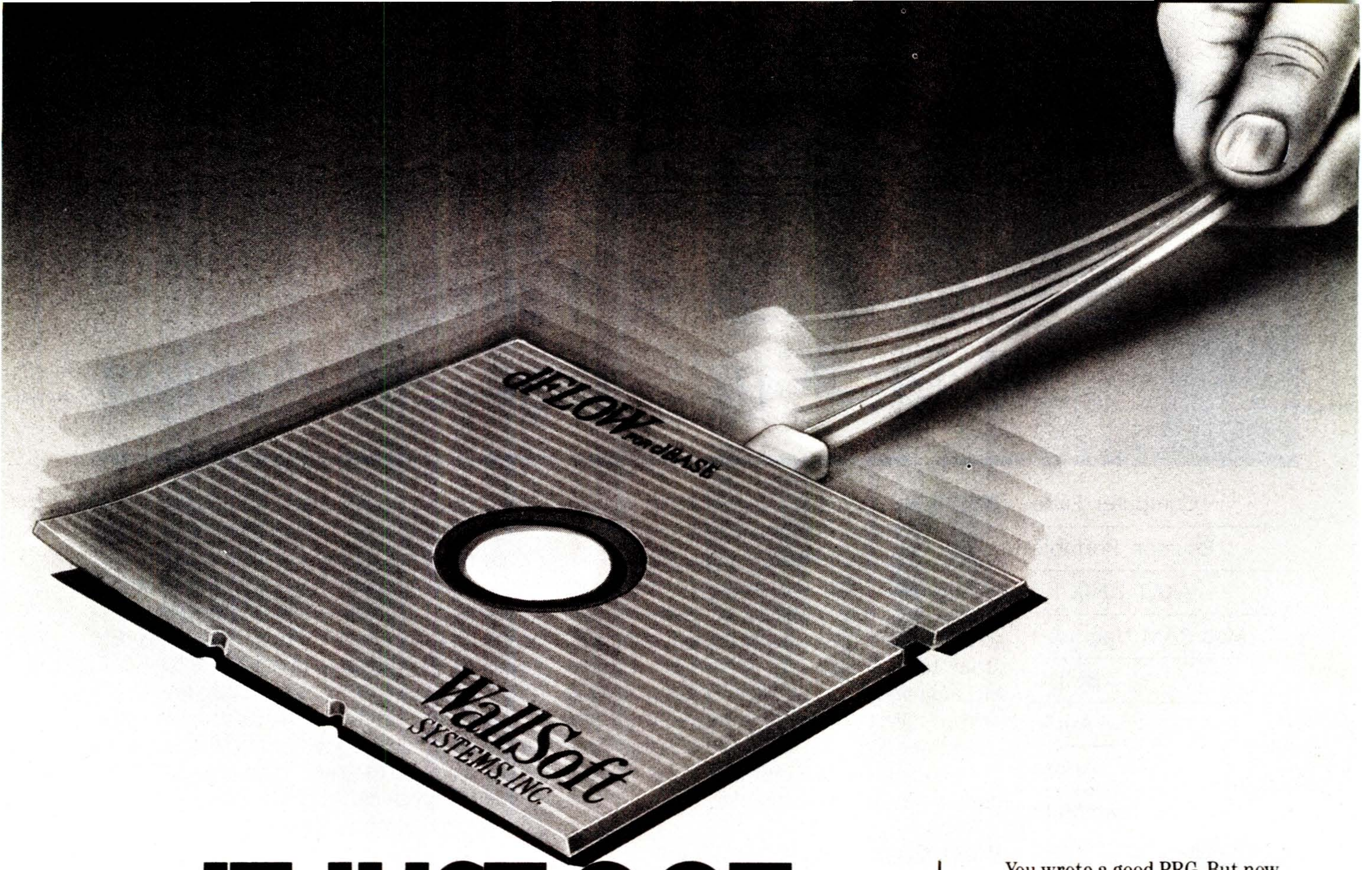
End users, on the other hand, are still having a great time. Some terrific bargains were to be found at the Faire. I bought 128K bytes (18 64K-bit chips) of RAM (random-access read/write memory) for my SixPakPlus board for only $21; 256K-bit chips were selling for as little as $5.50 in quantity one. I drooled a long time over a 21-megabyte internal hard disk for my Compaq that was selling for just $675 (with controller and cable). Complete computer systems were going at low prices. One example was a 512K-byte Macintosh with an external disk drive and an Imagewriter printer for $2594. Modems, printers, monitors, and graphics cards were selling for no-margin prices. I'm not sure if the vendors made any money, but I saw a lot of happy buyers walking out with large boxes and bags.

Some interesting products were on display. Ericsson, a Swedish company specializing in ergonomic (body-friendly) IBM PC-compatibles, showed a portable compatible with one 5¼-inch disk drive, 256K bytes of RAM, parallel and serial ports, and a plasma display for just $2995. If you're not aware of how expensive plasma displays usually are, here's one clue: IBM was showing one that hooks up to the IBM PC and that has about four times the resolution of the Ericsson (i.e., double the width and double the height). The IBM unit cost $3000 by itself. Ericsson is supposed to be sending an evaluation unit; if and when it shows up, I'll let you know just how nice it is.

AT&T—which has generally failed to live up to anyone's expectations as to how it would do in the computer market—displayed the UNIX PC (formerly known as the 7300). This is a 68000-based box with windows, lots of

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Bruce Webster is a charter member of the PMS Commandos and a consulting editor for BYTE. He can be contacted c/o BYTE, 425 Battery St., San Francisco, CA 94111.



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RAM, a hard disk, telecommunications hardware, and the UNIX operating system. The windows are an attempt to make UNIX palatable; however, without sufficient third-party software (ever UNIX's bane), there still won't be much demand for the machine. Again, an evaluation unit is supposed to arrive in a few months; I'll let you know more when I get it.

A number of interesting Macintosh products were there. Everyone and her sister seems to be offering RAM upgrades for the Macintosh, mostly because Apple still insists on charging the ridiculous amount of $700 for its 512K-byte upgrade. Competition is heavy; most firms are charging about $300, which is still high, given recent drops in 256K-bit chip prices. The current winner for biggest upgrade is Levco, which offers a 2-megabyte upgrade for less than $1000; the actual cost is dependent upon current chip prices. A friend of mine sat down at one of the 2-megabyte Macs, set up a 1.4-megabyte RAM disk (with the Assimilation Process software), and still had a full 512K-byte workspace left over. Not too shabby. (However, some dark clouds are on the horizon for Mac owners using third-party or do-it-yourself upgrades; see the "Mac RAM Upgrade Alert" section below.)

A variation on the Mac RAM disk is available from Western Automation Laboratories. This company is producing the *external* DASCH (disk acceleration/storage control hardware) RAM disk, something the Mac could have used a year ago. Several sizes are available, ranging from 500K bytes to 2 megabytes; ironically, the low-end (500K-byte) $500 drive is probably your best value, since you could buy a 10-megabyte hard disk for less than the price of the high-end RAM disk ($2000 for 2 megabytes).

A large number of users groups had booths, another indication that the Faire had a hard time selling its floor space to dealers and manufacturers. I gladly joined the Berkeley Macintosh Users Group (BMUG) (1422A Walnut St., Suite 153, Berkeley, CA 94709, (415) 849-9114); for $17, I got a 120-page "newsletter" (printed on a LaserWriter) and a disk of public-domain software. Another users group—Atari—had probably the most crowded booth at the Faire. They had two Atari 520STs (the Jackintosh) up and running for hands-on demonstrations, one running GEM (Digital Research's Mac-like environment) and the other running FORTH, more evidence that the machine is for real.

This, of course, is the spot where I should stop and pontificate about the future of the West Coast Computer Faire. However, most of you can guess (and "guess" is the right word) just as well as I can where things are going, and with just as much validity, so I'll skip the dramatics and move on to the next topic.

Mac RAM Upgrade Alert

It is now late April, and I just found out that this column won't see print until September. I wish it were otherwise, because I've recently come across some very disturbing news. A very reliable source has told me that a major ROM (read-only memory) upgrade for the Macintosh will happen this fall, about the time you read this. The new ROM will be 128K bytes (the current one is 64K bytes) and will incorporate fixes and changes to the operating system and Toolbox, support double-sided disks, and so on. This has been confirmed from other sources and is hardly disturbing news. However, this same source told me that Apple was instructing all its dealers *not* to perform the ROM upgrade on any Mac that has been upgraded or modified in any way other than the official Apple 512K-byte upgrade (board swap). In other words, if you were not willing to pay the $700 Apple wanted, but instead have done it yourself or gone to a third party, you are out of luck.

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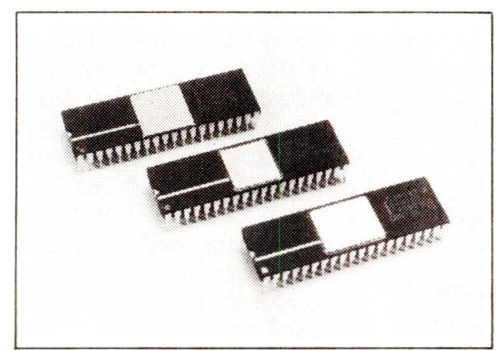
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I would like to dismiss this information as another crazy rumor, but I can't. First, my original source is someone who should know and claims to get this straight from Apple. Second, I have since heard the same news from two or three independent sources. Third, it fits in too well with other events at Apple, such as Steve Jobs forcing Frog Designs (the firm that did the IIc design) to stop all work on Steve Wozniak's new product, even though that product does not appear to be in any way competitive with Apple.

Apple shot itself in the foot last fall with the overpriced 512K-byte upgrade and has let the wound fester by keeping the price too high. This policy punished those who did the most to help the Mac succeed: Those who bought the Mac in its first few months, paying too much money for a machine with too little memory and almost no software. If Apple carries through on this latest plan, it will be hurting those same people again. What an irony! Apple (especially Steve Jobs) takes pains to paint itself as the "people's alternative" to IBM; yet IBM has shown more consideration for PCjr owners than Apple has for Mac owners.

All these problems and incidents make it appear as though Apple is in danger of self-destructing. I truly don't want that to happen; I prefer more competition in the field, not less. Besides that, I have a sentimental attachment to the company. The first computer I ever owned (though just for a few months) was an Apple II; the second was a Macintosh; and I bought a IIe late last year. So it saddens me to see the direction the company is going. Apple may have shot itself in the foot last year, but it now appears determined to shoot itself in the head.

AMIGA

Among its other faults, Apple has been shamelessly neglecting the Apple II family, and specifically the Apple IIe. When the IIc came out a year ago, Apple cut the price of the IIe and slowed production, figuring the machine would die of its own accord. Instead, IIe sales jumped dramatically, easily outselling the IIc. People would see the IIc ads, come into the computer store, and walk out with a IIe. Why? Because the IIe had *slots*, while the IIc (like the Mac) was a closed machine. The IIe is a chameleon: With the right set of boards, you can make it look like and do just about anything. Case in point: The nicest development system I've ever used, including mainframes and minis, was an Apple IIe with 128K bytes of RAM, an Accelerator IIe card (3.5-megahertz 65C02), and two Axlon 320K-byte RAM disks (configured as four 160K-byte floppy disks). Apple's response to the increased IIe sales was to cut back on production and raise its price (while discounting the IIc). Even so, it wasn't until late 1984 that the IIc finally started outselling the IIe.

What does this have to do with the Amiga? Well, several machines are competing in the low-end market: the Atari 520ST, the Apple IIc, the Mac (to a lesser extent), and the Amiga. Guess how many of these are easily expandable? Just one: the Amiga. Guess which machine will probably end up being the Apple II of the late eighties? I don't think the IIc will, nor the Mac, and the ST is a tightly closed, nonexpandable box. My vote is for the Amiga. From what I can see, the Amiga's graphics, sound, 68000 processor, memory map (allowing up to 8 megabytes of RAM), and expansion bus give it the potential of a long and successful life. There's always the chance that Apple will, indeed, come out with a souped-up Apple II next year, but even with the Western Design Center chips (65816, etc.) and the nifty 3½-inch Duodisk (1.6 megabytes of storage), it will probably be too little, too late.

UPDATES

I talked last month about TeamMate, the repackaged version of Jack2—a

(continued)

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$500 product—released by SofTech Microsystems at $69.95 for the IBM PC. Since then, I've had a chance to play with it. It has an easy-to-use, easy-to-grasp user interface and appears to be a truly integrated package, i.e., not just a few programs strung together by data-transfer modules. Unfortunately, I've never used Framework, Symphony, Jazz, Ovation (sorry, bad joke), or even (gasp!) Lotus 1-2-3, so I don't have much basis for comparison. On the other hand, at this low of a price you can hardly lose. I think it would be great for small businesses (or small departments in large businesses) that need a package to do invoices, financial reports, letters, and the like. All in all, it looks like a real bargain.

IN THE QUEUE

As I said at the start, I've been receiving a steady stream of hardware and software from the San Francisco office. A number of C compilers, for both the Mac and the IBM PC, have shown up, and my education in C is lurching forward. The GEM Programmer's Toolkit has come from Digital Research; maybe now my attendance at the GEM seminar will pay off. Sunol Systems has sent a disk-server network, with interfaces for the Compaq, Apple II, and Macintosh, but I haven't got it up and running yet. Two new languages for the Mac have arrived: ExperLisp, a compiling LISP from ExperTelligence, and Rascal (real-time Pascal), an I/O-oriented language developed at Reed College. Several information-management packages for the Mac are showing up as well, including Filevision and TimeBase. And Brenda just informed me yesterday that more boxes are on the way. Getting through all this may kill me, but, hey, I knew the job was dangerous when I took it. Take care, and I'll see you on the bit stream. ■



M·A·T·H·E·M·A·T·I·C·A·L R·E·C·R·E·A·T·I·O·N·S

π, e, and All That

Sneaking up on transcendental numbers

BY ROBERT T. KUROSAKA

God made integers, all else is the work of man.
—Kronecker

This famous quote of Leopold Kronecker serves as the starting point for this month's column. The integers (the whole numbers) can be used to construct other numbers.

We can construct rational numbers by dividing one integer by another. When we do so, we get either a terminating decimal (1/4=0.25) or a nonterminating, repeating decimal (7/18=0.388888 . . .). Repeating, or cyclic, decimals are a fascinating study I may explore in a future column.

IRRATIONAL NUMBERS

We can also construct numbers that are both nonterminating and nonrepeating. It is a rather amazing notion that a string of digits may go on forever without having to establish a pattern. It's such an odd notion that the ancient Greeks originally did not believe it possible—or even imaginable. When it was established that the square root of 2 was such a number, the Greeks called this kind of number irrational. The root meaning of irrational is "without ratio," or unable to be expressed as a fraction. The Greeks found such numbers irrational not only in the sense of "non-ratio-able" but also in the sense of "nonsensical."

The differences between rational and irrational numbers are substantial. It can be shown that no more rational numbers exist than do whole numbers, but irrational numbers outnumber rational numbers. This fact, which is often presented as a paradox, is not especially surprising when you look at how we have constructed rational numbers. They are built up out of whole numbers and can be expressed as integer fractions. As I said above, irrational numbers cannot be so expressed.

TWO TYPES

There are two different kinds of irrational numbers. The first, like the square root of 2, is called an algebraic irrational number. In algebra, we are restricted to some basic operations: addition, subtraction, multiplication, division, raising to a power, and taking roots. An algebraic number is one that can be obtained by a finite number of algebraic operations.

An alternate definition states that an algebraic number is one that is a solution of a polynomial equation. By definition, a polynomial is an expression that has rational coefficients and integer exponents. For example, the square root of 2 is one of the solutions of $x\hat{}2-2=0$. Similarly, $2+\sqrt{5}$ is a solution of the equation $x\hat{}3-5x\hat{}2+3x+1=0$. There are many algebraic numbers.

However, there exists a second class of irrational numbers that are not algebraic. They are not solutions of any polynomial equation, nor can they be calculated by a finite number of algebraic operations. These numbers, higher in the constructivist hierarchy of real numbers, are called transcendental numbers. Not only are you unable to write down the decimal value of a transcendental number, you are unable to explicitly write down how to calculate it. Oddly, some of these numbers are familiar to us. Among them can be found e, the base of natural logarithms, and π, or pi.

In this column, I'll look at some surprisingly ordinary hiding places for these extraordinary numbers. I'll also take a look at some ways of approximating the values of them. A well-known, but still amazing, equivalence is worth a quick mention. I have mentioned e and π. There is yet another number that is not irrational but imaginary (it's hard to keep your prejudices out of numbers). That number is, of course, i, the square root of -1, which stands at the door to complex numbers. Between π, e, and i, we seem to have the numerical equivalent of a circus freak show. But put them all together in the form of $e^{i\pi}$, and you end up with the ordinary number -1!

Perhaps the most extraordinary aspect of

(continued)

Robert T. Kurosaka teaches mathematics in the Massachusetts State College system. He invites your correspondence c/o BYTE, POB 372, Hancock, NH 03449.

transcendental numbers is that, although there are infinitely many of them, only π and e are immediately recognized by most educated people as transcendental. What makes these two the celebrities of the transcendental set? We'll try to get a sense of that as we proceed.

Pi and Coffee

Enough. On to the business at hand. The transcendental number π is equal to 3.1415926535. . . . This value can be easily memorized by learning this exchange: "May I have a large container of coffee?" "Cream and sugar?" Count the number of letters in each word and get the sequence: 3, 1, 4, 1, 5, 9, 2, 6, 5, 3, 5.

Pi occurs in circles and circular figures—ellipses, cycloids, and so on—but it also turns up in highly improbable situations. For example, if we calculate the area between the curve $y=1/\sqrt{1-x^2}$ and the x-axis for $x=-1$ to 1 (see figure 1), we find two surprises. First, the area is finite; second, the area is π square units.

If we consider the curve $y=1/x$ from $x=1$ to ∞ (see figure 2a), we are not surprised to find that its length is infinite, nor that the area between the curve and the x-axis is infinite. If we revolve the curve about the x-axis, forming a long funnel (see figure 2b), its surface area is also infinite (ho hum!). However, we get a pi in the face when we calculate the *volume* of this funnel: It is exactly π cubic units. The paradox is truly mind-boggling. We cannot paint the inner surface of the funnel—there isn't enough paint in the universe—but we can fill it!

Buffon's Problem

In 1760, Comte Georges-Louis Leclerc de Buffon devised an empirical method for determining the value of π. Parallel lines, spaced equally at a distance d, are drawn on a sheet of paper. A needle of length l, where l is less than d, is tossed onto the paper. Now consider the probability of the needle crossing one of the parallel lines. The "Buffon needle theorem" assures us that this probability is $2l/\pi d$.

We can recreate this classic experiment by computer simulation. Using a needle exactly half the length of the distance between the lines ($l=d/2$), the ratio of tosses to crosses should approach π.

I had hoped to tell you about an Italian mathematician, Lazzerini, who performed this experiment in 1901. I was disappointed to find that three books that discuss him give contradictory information and inaccurate arithmetic. One book gives 3400 tosses and 1082 crosses and notes that 3400/1082 differs from π by less than one-tenth of one percent. So far, so good. Another source gives 3407 tosses but not the number of crosses, yet it claims 3.1415929 as the ratio. (Can you find the number of crosses?) The third book gives 3408 tosses and 2169 crosses, using a needle equal in length to the distance between the lines. That author attains a certain measure of immortality by actually publishing the "fact" that $(2\times3408/2169=3.1415929$. Two of the authors hint broadly that Lazzerini's results have been looked upon with suspicion all these years—and small wonder!

You may already know that 355/113, or 3.1415929 . . . , has been noted as the "best" rational approximation of π because it provides eight-digit accuracy using only three-digit numbers. The fraction is easily memorized once you note the pattern 113355. Its discovery is credited to a Chinese mathematician, Tsu Ch'ung-chih, about the year 480.

Back to Buffon. In figure 3, the lines are d units apart. The needle has length $d/2$; the half-needle, $d/4$. When tossed at random, the needle will land with its midpoint a random distance x from the left-hand line and will make a random angle a with the horizontal. We want to know whether the left half of the needle crosses line 1 or the right half crosses line 2. We may therefore limit our attention to one-half of the needle, $d/4$, and ask whether the

(continued)

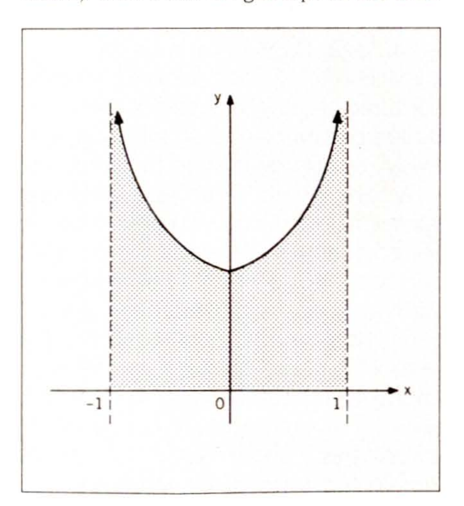


Figure 1: *Area under* $y=\dfrac{1}{\sqrt{1-x^2}}$.

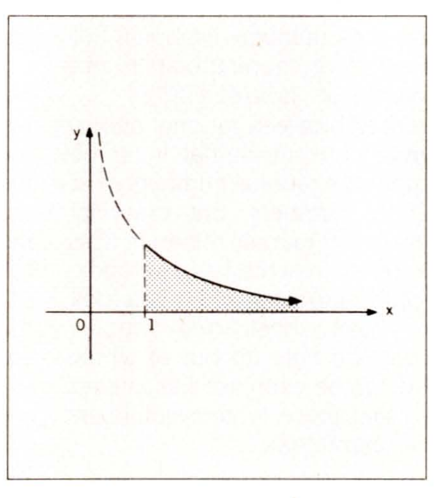


Figure 2a: *Graph of* $y=\dfrac{1}{x}$ *on* $[1,\infty)$.

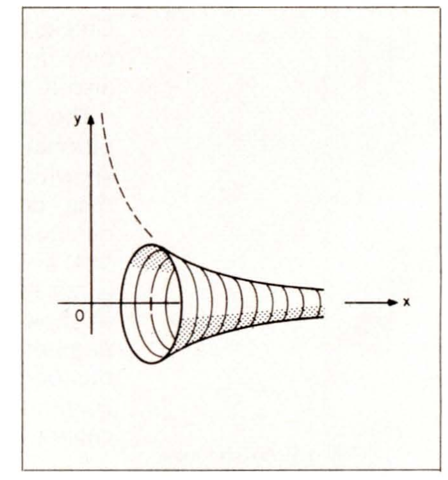


Figure 2b: *The funnel formed by revolving 2a around the x-axis.*

In Buffon's needle experiment, the transcendental number π emerges from operations involving only integers (tosses and crosses) and straight lines.

projection of $d/4$ onto the x-axis is greater than or equal to x (in which case the left half of the needle intersects line 1) or is greater than or equal to $d-x$ (in which case the right half of the needle intersects line 2). Listing 1 presents a program that performs the simulation for us. [*Editor's note: The listings in this article are available for downloading via* BYTEnet *Listings. The telephone number is* (617) 861-9774.]

I find something less than satisfying about this program. In Buffon's experiment, π emerges from operations involving only integers (needle tosses and crosses) and straight lines. The pleasure we take in it is akin to that we get when a magician pulls a rabbit out of a hat. In our simulation program, however, we use the number 1.57079633 in generating our angle measurement. As you may have noticed, this is nothing other than π/2 to nine-digit accuracy. In our program, we see the magician put the rabbit into the hat before the show begins.

Getting to First Base

Perhaps we can do better with e, the base of natural logarithms, which is equal to 2.718281828459045 . . . . This value can also be memorized. After mastering the initial 2.7, recite "Jackson, Jackson wore a pair of 45s until he was 90." Andrew Jackson was elected president of the United States in 1828; hence, two 1828s. Since he "wore a pair of 45s," the question arises, "Shouldn't the next digits be 454590?" The reply is, "He wouldn't wear both guns on one hip, would he?" This silly story was given to me by my good friend and colleague John C. Jacobs. As all good mnemonics do, its sheer absurdity hard-wired the information into my brain.

Check Your Euler

The number e turns up unexpectedly in a classic problem called The Careless Hatcheck Girl. This absentminded woman checked n hats for n men during a banquet. At the end of the evening, she returned the hats randomly to the men. What is the probability that no man received his own hat?

This seems to be a problem in elementary probability. The hats can be distributed in $n!$ (n factorial) ways. We must find the number of ways that n hats can be arranged so that no hat is given to its owner (the number of *complete* permutations). This is *not* an elementary task.

The derivation of the complete permutation formula is complicated and uses some rare and exciting techniques. I will make it available to interested readers on request. The formula is given here without proof. The probability of a complete permutation of n objects is

$$1/2! - 1/3! + 1/4! - 1/5! + \ . \ . \ . \ + (-1)\hat{\ } n/n!$$

(continued)

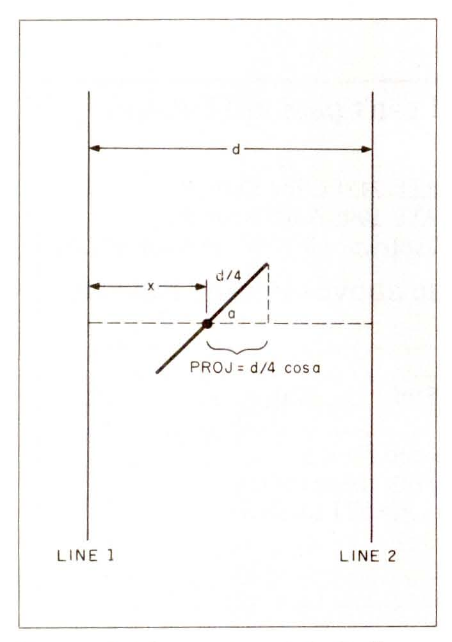


Figure 3: *The geometry of the Buffon needle experiment.*

Listing 1: *The Buffon needle experiment in BASIC.*

```
10  '*************************************************************
20  '*                 BUFFON'S NEEDLE EXPERIMENT                 *
30  '*                      BY BOB KUROSAKA                       *
40  '*************************************************************
50  CLS
60  PRINT "THIS PROGRAM APPROXIMATES THE NUMBER PI"
70  PRINT "BY SIMULATING BUFFON'S NEEDLE-DROPPING EXPERIMENT."
80  PRINT :PRINT
90  REM USE THE COMPUTER CLOCK TO SEED THE RANDOM-NUMBER
    GENERATOR.
100 SEED=VAL (RIGHT$(TIME$,2) )
110 RANDOMIZE(SEED)
120 INPUT "NUMBER OF TRIALS";TRIALS
130 FOR I=1 TO TRIALS
140      ANGLE=1.57079633#*RND(1)
150      X=RND(1)
160      PROJ=.25*COS(ANGLE)
170      IF PROJ>=X OR PROJ>=1-X THEN CROSSES=CROSSES+1
180 NEXT I
190 PRINT "NUMBER OF CROSSES:";CROSSES
200 PRINT "THE CALCULATED APPROXIMATION OF PI FROM THIS
    IS:";TRIALS/CROSSES
210 END
```

Many of you may recognize the pattern and rhythm of this formula—it is the first *n* terms of the Maclaurin series for e^*x*, where x = −1. That is, as the number of hats increases, the probability of a complete permutation approaches 1/e.

In our program (see listing 2), we will simulate the permutations of *n* hats. For *n* = 12, there are 176,214,841 complete permutations out of a possible 12!, or 479,001,600 permutations. The probability is 0.3678794413 . . . , and its reciprocal is 2.7182818274 . . . , accurate to the eighth decimal place. As in Buffon's needle experiment, the program allows us to repeat the experiment any number of times. It will randomly permute the *n* hats and count the number of complete permutations that occur. Then it will print the results and the ratio of number of trials to number of complete permutations, which should approximate e. In this program, we have managed to effect our simulation without sneaking the answer into the program beforehand.

The transcendental numbers π and e seem to be woven into the very fabric of mathematics.

Listing 2: *The* BASIC *hatcheck girl simulator.*

```
10  '**************************************************************
20  '*               THE TRANSCENDENTAL HATCHECK GIRL              *
30  '*                        BY BOB KUROSAKA                       *
40  '**************************************************************
50  CLS
60  PRINT "THIS PROGRAM APPROXIMATES THE NUMBER 'e' BY A MONTE
    CARLO SIMULATION"
70  PRINT "OF A HATCHECK GIRL WHO RANDOMLY RETURNS HATS TO
    CUSTOMERS."
80  PRINT :PRINT
90  INPUT "HOW MANY HATS SHOULD I USE";N.HATS
100 DIM HAT (N.HATS)
110 RANDOMIZE (VAL (RIGHT$(TIME$,2) ) )
120 INPUT "NUMBER OF SIMULATIONS TO RUN";N.TRIALS
130 CLS
140 '
150 REM RUN THE SIMULATION N.TRIALS TIMES
160 '
170 FOR TRIAL = 1 TO N.TRIALS
180 '
190       REM ASSIGN THE HATS TO THEIR RIGHTFUL OWNERS
200 '
210         FOR OWNER = 1 TO N.HATS
220             HAT(OWNER) = OWNER
230         NEXT OWNER
240       OWNER = 1:FOUL.UP$ = "PERFECT"
250 '
260       REM RANDOMLY RETURN THE HATS. IF NO ONE GOT THE RIGHT
            HAT, ADD ONE TO THE COMPLETE PERMUTATION COUNTER
            (COMP.PERM).
270 '
280       WHILE OWNER< = N.HATS AND FOUL.UP$ = "PERFECT"
290             RECIPIENT = INT(RND(1)*N.HATS) + 1
300             IF HAT(RECIPIENT)< >0 THEN HAT(RECIPIENT) = 0 ELSE 290
310             IF RECIPIENT = OWNER THEN FOUL.UP$ = "IMPERFECT"
320             OWNER = OWNER + 1
330       WEND
340       IF FOUL.UP$ = "PERFECT" THEN COMP.PERM = COMP.PERM + 1
350 NEXT TRIAL
360 PRINT "WITH A TOTAL OF";N.HATS;" HATS AND";N.TRIALS;"
    SIMULATIONS,"
370 PRINT "THE HATCHECK GIRL GAVE EVERYONE THE WRONG
    HAT";COMP.PERM;" TIMES"
380 PRINT "THE APPROXIMATION OF e THIS GIVES IS";N.TRIALS/COMP.PERM
390 END
```

WINDING DOWN

It is both amazing and amusing that π, which is found in that most symmetric figure, the circle, should be a nonterminating, nonrepeating decimal number—a most unattractive number. Yet π is somehow fundamental to mathematics. All angles are measured in radians (2π radians equal 360 degrees); otherwise, awkward adjustment factors must be introduced. The same holds true for e. As an undergraduate, I wondered what could possibly be "natural" about natural logarithms. Yet calculus demonstrated that e is the most convenient base of all. The symmetry of e is perhaps more abstract than that of π. For the curve defined by e^*x*, the slope of the tangent at the *y*-axis is 45 degrees. But this is also a fundamental kind of symmetry. All other bases would require adjustment factors.

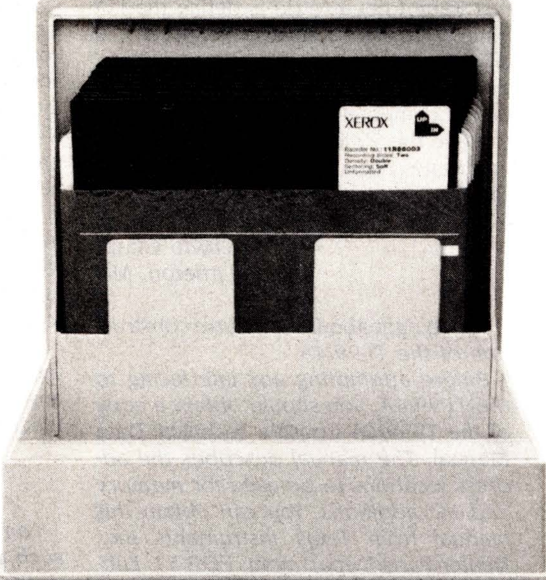
It appears that π and e are constantly lurking in the shadows, snickering as we trip over them. More seriously, these two powerful numbers seem to be woven into the very fabric of mathematics.

In closing, I want to at least mention my favorite irrational number: the golden mean, $\phi = (1 + \sqrt{5})/2 =$ 1.6180339887 . . . . As you can see, it is an algebraic irrational number, not a transcendental number. But it also turns up in surprising places. One hiding place is the Fibonacci sequence: 1, 1, 2, 3, 5, 8, 13, 21, . . . , a purely additive sequence of integers. I leave you with the challenge of discovering ϕ in that sequence. ■

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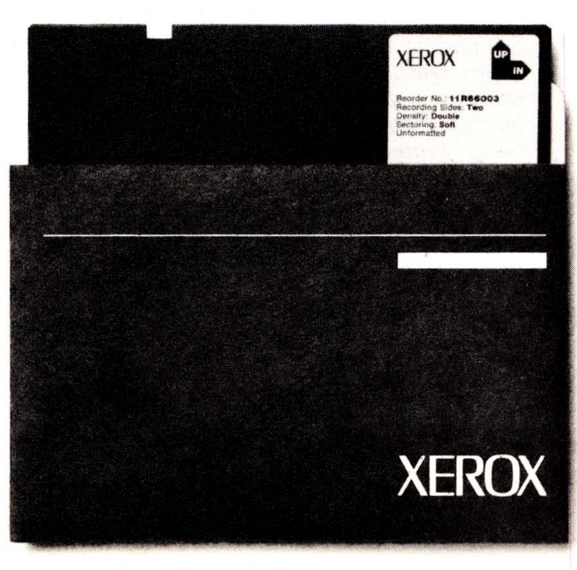
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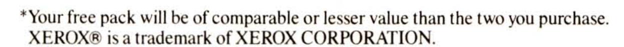
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Conducted by Steve Ciarcia

TI-99/4A Memory Expansion

Dear Steve,

I own a TI-99/4A home computer. I am presently using a cassette for additional storage. I would like to build my own memory-expansion board and/or floppy-controller board because the built-in 16K bytes of the 99/4A is too small for what I want to do.

I read your article "Build the Disk-80: Memory Expansion and Floppy-Disk Control" (March 1981, page 36). It seems the first thing I need to do is define the I/O pins on the edge connector. However, TI's documentation does not describe these pins in any way. I am reluctant to dismantle my computer, which would allow me to trace the 9900's I/O lines to the edge connector, because TI used a somewhat bizarre construction that shields the main PC board.

David Gehly
Littleton, MA

You're right about the bizarre construction of the TI-99/4A.

Before attempting any interfacing to the TI-99/4A, you should obtain a copy of the TI-99/4A Console Technical Data Manual. *The manual describes the address locations to be used for memory and I/O additions. You can obtain this manual from Texas Instruments Inc., Dealer Parts Department, POB 53, Lubbock, TX 79408.*

I am not aware of any articles on building a memory expansion or a floppy-disk interface for the TI-99/4A. However, a good source of information on the TI-99/4A is the series of articles being written for Computer Shopper *magazine by Randy Holcomb called "Randy's Ravings." These articles cover many of the technical aspects of the TI-99/4A and the peripherals available for the system. You can probably obtain this type of information by writing to Randy Holcomb at Computer Shopper, 407 South Washington Ave., POB F, Titusville, FL 32781.*—Steve

Call-Status Monitoring

Dear Steve,

I have built a 6809 single-board computer to use as a household controller/burglar alarm. The program flow follows your outline in "Build a Computer Controlled Security System for Your Home" (January through March 1979) exactly and runs like a charm.

Accessory boards add BSR lighting-system control and inputs for a wireless alarm receiver similar to the one you used in your articles. An SC-01 speech synthesizer will deliver a message upon acknowledgment of an alarm condition to any phone number(s) I choose.

The only problem I'm having is monitoring the status of a phone call from the computer. If the computer calls a number and it's busy, it will go ahead and deliver the message regardless. The same thing will happen if the call wasn't switched properly by the phone company and never gets through.

Your article in a recent BYTE detailed the frequencies of the tones to monitor (dial tone, busy, ringing). I haven't had any luck using NE567 tone decoders, possibly due to the slow response at lower frequencies.

Could you please tell me how to monitor the progress of these status tones? Does anyone make a chip that performs this function?

Stephen J. Blair
APO San Francisco

I am glad to hear that you are getting such good performance from my computer-controlled security system, and I hope the following information will help you in expanding the system.

Special chips are available that recognize dial tones, busy signals, ringing tones, and recorder tones (commonly known as call-progress tones). The January BYTE detailed the information that you are looking for in the Circuit Cellar Feedback column.

See "Do I Have Circuits?" on page 414 for complete information on the chips you need. Also see "Build the Touch-Tone Interactive Message System" (March, page 98).—Steve

Searching for Books

Dear Steve,

I want to build my own computer, but I need help in obtaining good books on the subject. You see, English books on computers are rare here, must be ordered (which takes centuries!), and once ordered must be bought even if the book turns out to be a lemon.

I am interested in what operating systems I can run on a Z80, what software is available, and which controllers (for disk, video, etc.) I can interface to it. I would also appreciate any information on 16-bit computers, since I cannot go into my local bookstore and browse through books of this kind in English.

D. Koohdor
Bern, Switzerland

The books below should be helpful.

Practical Interfacing Techniques for Microprocessor Systems *by James W. Coffron and William E. Long (Prentice-Hall, 1983). Written for the serious hobbyist who is exploring interfacing techniques for the first time, it is a very complete yet clear description of the requirements to interface memory and peripheral devices to a microprocessor.*

Microprocessor Interfacing Techniques *by Rodnay Zaks and Austin Lesea (Sybex, 1979). This book covers much of the same material as the above-mentioned book but complements it by extending the discussion to cassette tape recorders and floppy-disk drives.*

A more advanced but clearly written book that covers many of the topics you mentioned is Microcomputer Interfacing *by Harold S. Stone (Addison-Wesley, 1982). In addition to many practical examples, the book also features state-of-the-art information so that an appreciation of the sophistication of new devices can be obtained.*—Steve ■

Over the years I have presented many different projects in BYTE. I know many of you have built them and are making use of them in many ways.

I am interested in hearing from any of you telling me what you've done with these projects or how you may have been influenced by the basic ideas. Write me at Circuit Cellar Feedback, POB 582, Glastonbury, CT 06033, and fill me in on your applications. All letters and photographs become the property of Steve Ciarcia and cannot be returned.

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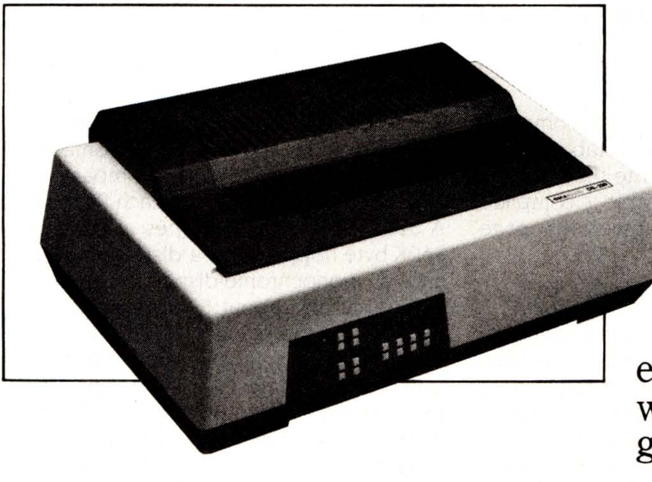
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Conducted by Sol Libes

Verbatim recently demonstrated a prototype 3½-inch erasable optical disc to prospective OEMs. It stores 47 megabytes (unformatted). That's not much as optical-disc drives go, but the current opticals are all write-once, read-only. Verbatim is reportedly shooting for third-quarter 1987 production with an OEM price of $300 and $20 to $30 for the removable discs.

OEM prices for 10-megabyte hard-disk drives are now well below $200, with 20-megabyte drives below $300. Prices are expected to go even lower in the next 12 months as Japanese and Korean makers start competing with U.S. vendors. Even prices on larger drives should be affected in what some feel will be a bloodbath for U.S. hard-drive makers. . . . Within two weeks of Lotus shipping Jazz, some West Coast dealers were advertising 40 percent discounts on the product. . . . Now that IBM is beginning to ship PC network systems, dealers are finding that many popular software products, such as Lotus 1-2-3, Framework, and dBASE, do not work properly in a network environment. No doubt these vendors will have to bring out special versions of their software for these system users. . . . Several Lotus 1-2-3 clones are shortly expected to hit the market and sell for a fraction of the cost of the real thing; expect Lotus to announce a new, greatly enhanced version. The question now is: Will users go for expensive bells and whistles or low-cost compatibility?

Table 1: *Top 10 microcomputer manufacturers as compiled by* Datamation *magazine. Revenues are for 1984, in millions of dollars.*

1. IBM	$4000.0
2. Apple Computer	1897.9
3. Commodore International	1129.5
4. Hewlett-Packard	510.0
5. Sperry	503.4
6. Tandy	402.8
7. Convergent Technologies	361.7
8. Compaq Computer	329.0
9. Ing. C. Olivetti	289.6
10. NEC	258.9

Experts are predicting that 1986 will be the year of the low-cost 3½-inch hard disk. Just as no manufacturer would think of introducing a computer without at least one floppy drive, all new systems will contain a hard-disk drive. The reason is that prices for 3½-inch drives should be far lower than the current 5¼-inch units. Using a small fraction of the parts employed in current hard-disk drives, occupying less than a third of the space (say goodbye to separate controller cards and expensive cabling) and less than a quarter of the weight, the smaller drives are expected to provide a greatly improved level of reliability.

Rumor has it that AT&T is getting ready to enter the optical-storage arena via a cheap wallet-size card holding 2 megabytes or more of data. The product is probably an option for AT&T's 6300 and 7300 desktop systems.

The Top Ten

Do you know the top 10 microcomputer makers? Without looking at table 1, take paper and pencil and write their names. Now look at the list in table 1 compiled by *Datamation* magazine (June 1985, page 38).

Apple Bytes & Pits

Apple recently showed its first quarterly loss ever and is experiencing severe belt-tightening as it, and the industry as a whole, attempts to weather a slackening of growth in the personal computer industry. Apple laid off 1200 employees in June, only a month after laying off 1600 employees. It has trimmed about 40 percent of its staff, closed three plants, and consolidated operations.

Working on the cutting edge of technology, as Apple has traditionally done, is a good strategy in a young, rapidly growing market. As the personal computer industry matures and supply catches up with demand, marketing becomes more important than technology. The pioneers either reorient their efforts from product innovation to product selling or fail to compete. Apple now appears to be going through that transition and remolding its operation into the IBM-type marketing-oriented computer maker.

Apple is expected to introduce several new products that will upgrade the power of the venerable Apple II. Anticipated this fall are plug-in cards that can increase the unit's memory up to 1 megabyte in 256K-byte chunks and a 3½-inch disk drive that stores nearly a megabyte. Also expected early next year is the 16-bit microprocessor upgrade.

IBM Watching

Even IBM is feeling the current recession in the computer business. IBM president John Akers recently said that business for the first nine months of 1985 will not measure up to the same period last year and profits for the year will be lower than last year.

Did you know that IBM has 394,930 employees and, according to *Datamation* (June 1985, page 42), the average revenue per employee was $112,200 for last year? That makes IBM one of the most profitable computer companies in the world.

According to *PC Week* magazine (June 11, 1985, page 1), IBM's highly automated production line enables the company to make a 55 percent profit on each PC sold. A $2520 PC with 256K bytes of RAM, a 360K-byte floppy drive, a disk controller, and a monochrome-display controller card costs IBM about $700 to produce.

IBM is now marketing the JX in Australia. The JX is made in Japan and has been on sale there for almost a year. It runs MS-DOS; contains two 360K-byte 3½-inch floppies, 512K bytes of RAM, and a cartridge slot; and is not expandable. The unit is seen as a lower-cost, Japanese version of the PCjr. There are rumors that IBM is seriously considering marketing the unit in the U.S. (after selling out its current inventory of PCjrs).

Incidentally, after the recent backlash to

(continued)

BYTELINES, *news and speculation about personal computing, is conducted by Sol Libes, the author of numerous books and articles on computers. He is the founder of the* Amateur Computer Group of New Jersey *and a coorganizer of the* Trenton Computer Festival. *He edits and publishes* Micro/Systems Journal, *a bimonthly publication for system programmers and integrators. He can be contacted c/o* BYTE, POB 372, *Hancock,* NH 03449.

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IBM's announced cessation of PCjr production, IBM adopted the policy of not commenting as to whether any product is in production. It will only confirm whether or not the product is being shipped.

IBM is also rumored to be planning the introduction of several coprocessor-equipped ATs, in addition to the already-announced desktop 36. These are expected to include a UNIX (Berkeley 4.2) unit based on the National Semiconductor 32032 32-bit microprocessor and an 801 unit for the scientific market. These machines would be sold by IBM's advanced dealer program available only to large chains.

CONTINUOUS-SPEECH INPUT SYSTEM

Kurzweil Applied Intelligence Inc. (411 Waverly Oaks Rd., Waltham, MA 02154) has introduced the first commercial voice input system capable of handling continuous speech. It can learn speech from many users in several languages with a 1000-word vocabulary (a 10,000-word beta-test unit is expected later this year). The company claims 100 percent accuracy. Units that are currently on the market work only with interrupted speech, have smaller vocabularies, and have far less accuracy.

The unit is a board-level product that will sell to OEMs for as low as $3000 in quantity. PC, multibus, and RS-232C versions already exist in which the unit acts as a keyboard input device. The unit is speaker-adaptive and performs better the more it "talks" with the same user.

Called the KVS-3000, the unit comprises three boards, an input analog-to-digital converter with signal conditioning, an acoustic pattern processor recognizing 3000 utterances, and a speech processor (using a 68000) that assembles recognized strings of speech and handles I/O to the host system.

CD-ROM UPDATE

At the recent Consumer Electronics Show in Chicago in June, Activenture Inc. (Pacific Grove, CA) demonstrated the first compact disc containing the complete text for an encyclopedia. It used less than a quarter of the 550-megabyte storage capacity of the 4¾-inch-diameter disc (using the Sony/Philips standard). Activenture showed an improved retrieval system that allowed retrieval of data in less than 3 seconds. The technique employed an index file as large as the 60-megabyte data file.

And Reference Technology Inc. (Denver, CO) announced the availability of the first CD-ROM drive with an IBM PC interface and software driver. The unit lists for $1535 plus $100 for the software. National Decision Systems (Encinitas, CA) announced a 1-gigabyte disk for that drive that contains marketing and demographic databases previously stored on a large minicomputer.

Both Sony and Philips are shipping evaluation samples of the bare drives to OEM customers. It is believed that these include Atari, Commodore, IBM, and Apple. Atari is already promising such a unit for its new ST computers with an expected selling price of $500.

CREDIT-CARD SOFTWARE

Mitsubishi Plastics Industries Ltd, in cooperation with Hudson Soft Ltd., both

(continued)

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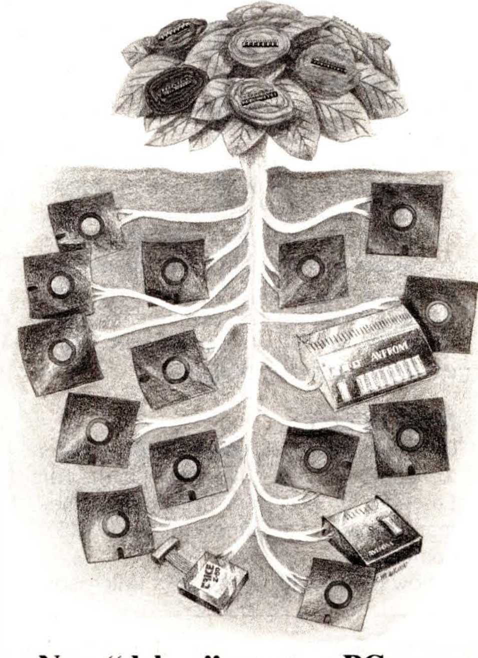
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of Japan, has introduced a new way to distribute software. The software is contained in a plastic credit-card-like package about twice the thickness of a standard credit card. The card contains either a 1-megabyte masked ROM or a 256K-byte programmable ROM or EEPROM. The 32 plated traces at one end of the card form the edge-card connector. You can insert the card into your personal computer's interface adapter.

The first software card to be introduced contains a game and costs $19.20. An adapter for MSX-based systems costs $5. An adapter for Commodore 64 systems is expected shortly.

Matsushita Electric Works Ltd. (Osaka, Japan) has already constructed an experimental automatic blood-pressure measuring system that writes data to an EEPROM-type card. The card is then inserted into an interface adapter connected to a personal computer for read-out and analysis.

Hudson Soft is planning to install vending machines with cards that are programmed when a purchaser buys an item. The purchaser will probably be able to use a credit card to buy the card.

Microcode Copyright Dispute

A court battle with far-reaching implications is in progress. Intel Corp. is suing NEC charging that NEC's new V series of microprocessors violates its microcode copyright. Microcode determines the fundamental instruction set for a processor.

NEC claims that it did not copy Intel's microcode for the 8086 16-bit microprocessor, that microcode is not protected anyway, and that Intel is harassing NEC's customers with this suit. A win for Intel will greatly strengthen the position of companies with proprietary computer architectures. A loss will let competitors freely emulate computer designs.

MSX Update

Over one million Z80-based MSX systems were sold in the last 12 months in the Far East and Europe. Over a dozen companies manufacture consumer-oriented MSX computers.

Now the developers of MSX (Microsoft and ASCII Japan) are promising to shortly release MSX-2, supporting 3½-inch floppies and a 512- by 512-pixel 256-color display, with a base price below $400. Preproduction models are expected to be shown at the October Japan electronics show. And IBM is known to be taking a very close look at MSX.

As yet, MSX has not made any inroads in the U.S., primarily because of the high $200 to $300 retail price and lack of floppy disks.

The One-Stop Shop

Where else but in Silicon Valley can you make a quick trip to an all-night market for a quart of milk or loaf of bread and also pick up some EPROMs, a PC or two, some memory chips, or a copy of Lotus 1-2-3 at discount prices? If you are in Sunnyvale, California, head for Fry's Electronics, a part of the Fry's Food and Drug supermarket chain advertised as the place for "fast, one-stop shopping for the Silicon Valley professional," where you can get your three Cs: computers, components, and convenience foods. ■

a message to our subscribers

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LETTERS

novation is that it is not a computer! At least, most are not using it as one; it is an expensive drafting aid. Also, the degree of "proprietariness" in the Mac (ROMs, custom chips, disk format) means that true clones will not appear to drive the price down and the performance up, as has happened with the IBM PC and the Apple II. The Mac will remain as limited and as expensive as it is today, and the Stride 420 will remain the best 68000 computer, as evidenced by the number of blatant clones emerging (not to be advertised by me). Please note I am not a Stride employee, just a satisfied and partisan customer.

P. MATSON
Reno, NV

MORE STRUCTURE, NOT LESS

From his letter, I fear that Erwin S. Strauss ("Toward a Less Structured Approach," May, page 458) has not fully understood structured programming. Structured programming has never been an attempt to have "fewer lines, fewer statements, fewer variables"; although he is correct that it is supposed to be easier to read and understand.

His examples are too small to say anything about structured programming. Any discipline, or no discipline, will work for sufficiently short programs; if you can hold the program in your head as you're writing it, you don't need any help. But if the program is too large to know entirely, if you're not the only person working on it, if you expect to change it three years from now to run on a different computer, you must be able to understand it from reading the code.

The essence of structured programming is that a program should be composed of small building blocks, each with some clear and understandable function, connected in an understandable way. Repeat this as often as you want: The building blocks of one level are themselves composed of smaller subprograms. The advantage of this is that you, the programmer, can understand the program (or any subprogram) on its own ground; you need to know what the subprograms do, but not how they do it.

Most languages have primitive operations, like input and output; would you want to have to know how your OPEN statement does disk accesses before you could use it? Probably not. The ideal structured program treats any complicated operation—the ones that you wrote yourself—the same way. You don't want to have to think about how your B-tree algorithm works except during the algorithm; the rest of the program should treat it as a magical amulet that does disk lookups.

This has a number of advantages. It's easier to write programs. You can write the top level of a program as if in an ultrahigh-level language with commands that do precisely what you want. Then write each of those commands as a subroutine in a slightly lower-level language, and so on, until you're writing in the real computer language. For example, the top level of a spreadsheet might be

```
Initialize_Everything
LOOP
  Display_The_Changes_That_Affect_
  The_Screen
  Get_A_Command
  If The Command_Is_Quit THEN
    EXIT
  ELSE
    Do_The_Command
  END_IF
END_LOOP
Finish_Up
```

That is the main routine.

It is also easier to debug programs. With a moderate amount of care, each of the commands is independent of all the others except those that it calls (strictly, that it or any of its callees, recursively, calls). If you want to rewrite your Get_A_Command, fixing bugs or adding features or moving it to another machine, you will *know* that your changes won't damage any of the rest of the program. You don't have that guarantee in a nonstructured program; it is quite likely that you will have to make changes in all the rest of the code.

Structured programming encourages modifying parts of the code to make them work better and be friendlier. When the details of entering a command can confound the screen-refresh routine, I'm going to hesitate a long time before I touch the command-reader. If they're separate, I won't worry. Also, when I change things in the command-reader, a lot of its subroutines will still be useful; I'll already have most of the tools I need.

In fact, structured programming is a way of avoiding discipline on a small scale. When I wrote the body of the spreadsheet, I didn't think in any especially structured way or make any particular attempt to make it easy to understand. It's only 11 lines of code and not very dense at that; there's not enough there to have trouble with.

If every routine is too small and too easy to understand to have trouble with, where are you going to have trouble? (That's way, way oversimplified, but it has the right idea. You will still have bugs—there are always bugs—but they're easier to fix.)

I cannot understand Mr. Strauss's objection to structured programming from his letter. In one paragraph, he seems to think that "one of the costs of structure is insensitivity to the end user." In another, "structured programming is a fine thing in a production-type environment." This seems to imply that it is a fine thing for widely distributed programs to be insensitive to the end user, but local and temporary programs should be friendly. I rather doubt that he intended this. Saying that "debugging can come later" is rather peculiar: it is very easy to write a program that does great things—except that it doesn't work.

The quality of a program doesn't have anything to do with its programming discipline. Designing the program (especially the part the user sees) and writing it should be as separate as possible; in his example, the style of printing the index should have been chosen at leisure by the designer, not on the fly by the programmer. I guess that Wirth didn't do this; shame on him.

I suggest that anyone critiquing structured programming (or anything else) critique the discipline itself, rather than a vague impression of it.

BARD BLOOM
Cambridge, MA

CAN THIS PUZZLE BE SOLVED?

It certainly is no secret that this world contains more than its share of frustrations. However, I'd sooner take on writing a program in BASIC to calculate to the last digit of pi than try to solve the Rubik's Cube on the cover of your June issue. How can this puzzle be solved with two blue squares in the middle?

SUZIE R. MAGALLANES
Scotts Valley, CA

Gregg Williams replies:
Thanks for allowing me to say "I told you so." When Robert Tinney came up with his Rubik's Cube idea for the June BYTE cover (I was the theme editor), I told him he'd better base his painting on a real Rubik's Cube. Otherwise, I told him, there'd probably be some inconsistency in the image he came up with, and some BYTE reader would surely find it. When he declined to do so, I found a few edge- and corner-cube errors, but I completely overlooked the fact that each center

(continued)

face must *be a different color! Thanks for confirming my high opinion of the BYTE reader.*

PAYING EXTRA FOR MANUALS

Yesterday, the disk I use for word processing gave me a system error number 10. However, when I tried to find the English translation of this error message, I discovered that the manufacturer had not bothered to document any error messages, so as to "enhance" the user-friendliness of its manuals.

No, this was not some Japanese import. It was that bastion of user-friendliness, Apple Computer.

I later learned that Apple did in fact document the Macintosh system errors in a separate manual, which costs an additional $100. No other personal computer company in the world would charge me for an essential reference manual after I'd spent $4000 on a computer system. It appears that Apple should take some lessons from its more experienced competitor, IBM. IBM documented all possible error messages for the IBM PC in its standard manual and charges only $39 for its technical reference manual for true hackers.

RICHARD SINGER
Berkeley, CA

YET ANOTHER GEM

I found "Public-Domain Gems" by John Markoff and Ezra Shapiro (March, page 207) to be both interesting and valuable, but I want to point out one gem that they overlooked.

No Visible Support Software (Box 1344, Berkeley, CA 94704) distributes a public-domain FORTH called F83 that fully observes the FORTH 83 standard. F83 was written by Henry Laxen and Michael Perry and is available for a variety of microprocessors, including a version that runs under PC-DOS. (In the DOS version, all I/O goes through DOS, except cursor positioning and clear screen, which go through BIOS.)

F83 from No Visible Support costs $25 for disk and handling (the software is free). The source disk sent to the purchaser is compacted by means of a Huffman code; the unpacking program is on the disk and produces two disks' worth of code. The code is also found on various bulletin boards; the most recent version of F83 is version 2.1.

Because F83 is an exceptionally clean and powerful implementation, it is becoming widely used as the basis for a variety of languages and products.

MICHAEL HAM
Santa Cruz, CA

COMPUTERS IN JAPAN

As far as I can tell from sources who are familiar with Japan, the personal computer boom has soured in Japan. While the major contenders try in vain to stir interest among buyers with new product offerings, NEC is still strengthening its "full nelson" on the market (nearing 70 percent share, with Fujitsu taking up second with some 20 percent).

The home/game market that the MSX technology was supposed to spark is stale; all the talk of "new media" and "INS" still seems to elude the family market. The remaining game machines are now in the $45 range, rather than the $360-to-$450 range of the MSX machines.

Sord—Japan's Apple and crown prince of that country's fledgling venture business—is in deep trouble with a devastated earnings picture and deep internal rifts in management. Its proprietary PIPS operating system has been more or less abandoned. Sord's forthcoming $600 large-screen LCD word-processing portable may be its last hurrah as a player in the export market.

Apple-Japan, along with its partner Canon Hanbai in Japan, has run into trouble with its attemps to develop functional kanji firmware for the Macintosh; attempts to generate kanji character sets on the Mac would end up entirely incompatible with the existing Mac operating system. The project seems to have been shelved, and Apple is resigned to marginal sales performance. But even the unmodified Macs were selling for astronomical prices—698,000 yen list ($3150).

The Japanese have so far found computers best suited to the office environment (with suitable clerical staff to operate them). Their impact has unquestionably been solid and is still widening. If and when the Japanese "invasion" ever arrives in the U.S., it will be in integrated OA systems (word-processing, optical filing, facsimile). But even then, the software requirements for the U.S. and Japanese office environments are virtually incompatible. In the long run, we may see a strong presence in Japan only by IBM (with its successful 5550 series) and, conversely, in the U.S. only by the local subsidiaries of NEC and Fujitsu. The Sharps, Epsons, Mitsubishis, Sords, and Kay Nishis are not likely to remain as long-term competitors.

I may well be wrong on a number of counts, so I look forward to reading more updates in BYTE on the Japanese situation.

PETER E. FUCHS
The Program on U.S.–Japan Relations
The Center for International Affairs
Harvard University
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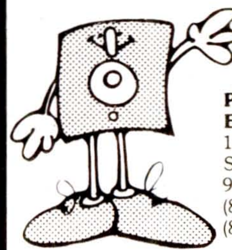
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Inquiry 35

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model	description	price
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	Eprom, -N with no ram	$169
FDC1	Floppy controller, 765, DMA, serial, moni/boot	$325
Support1	4serial, centronics, Sasi, interrupts, clocks	$345
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Z80 CPU	6, 8mhz, with memory mapping, addressable 4mbytes	$249

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Inquiry 324

NEW SYSTEMS

VersaBraille II

Telesensory Systems has introduced the VersaBraille II system, a portable, disk-based electronic information processor for the blind. This braille computer lets you electronically store, process, and retrieve information. A special telephone modem can link VersaBraille II to other computers.

VersaBraille II consists of a standard 3½-inch microfloppy-disk system and a braille display that substitutes for a video monitor. Its memory holds up to 30,000 characters; disk support boosts the unit's capacity to 77,000 characters. This is adequate for many word-processing procedures, such as formatting, high-speed searching, and inserting, deleting, and relocating text. The system can simultaneously output braille and print information.

VersaBraille II is fully programmable. Menus guide the user to each of the system's programs. The manufacturer provides special software that converts VersaBraille II into a four-function calculator with algebraic logic, floating decimal point, square root, and percent. Plans for other software packages include a 50,000-word spelling checker, a two-way braille translator, and a language interpreter.

The price of a VersaBraille II system is $6995 plus shipping and handling. For more information, contact Telesensory Systems Inc., 455 North Bernardo Ave., POB 7455, Mountain View, CA 94039-7455, (415) 960-0920.
Inquiry 615.



HP's *Series* 300 *technical workstation.*

Hewlett-Packard's Series 300

The Series 300 technical workstations from Hewlett-Packard expand the HP 9000 family. A modular design lets you choose the CPU, display, systems software, programming language, and peripherals.

For an entry-level to mid-range system, you can choose a 10-MHz Motorola 68010. If you require high-speed processor performance, a 32-bit 16.6-MHz 68020 is available. With both CPU configurations, you get 1 megabyte of RAM, expandable to 7½ megabytes.

Low-resolution display choices include two 12-inch monitors with 512 by 400 pixels in black and white or color. You can also choose a 19-inch color or 17-inch monochrome high-resolution monitor with a 1024- by 768-pixel display.

The Series 300 runs most Series 200 applications software. Packages are available for word processing, spreadsheets, database management, project management, and graphics. You can choose an integrated word-processing/spreadsheet/database package or programs for electrical and mechanical engineering. BASIC 4.0, Pascal 3.1, and HP-UX are also available.

Peripheral options include digitizer tablets, mice, mass-storage subsystems, printers, and plotters. Two IEEE-802.3 standard cabling options allow linking up to 30 systems over a distance of 185 meters or up to 100 computers over a distance of 500 meters. Series 300 network software provides file transfer, file access, and directory access within the HP 9000 system.

Series 300 prices start at $3500. A typical system ranges from $5500 for an entry-level configuration to $55,000 for a high-end system. Contact your local Hewlett-Packard sales office.
Inquiry 616.

Micro Five AT-Compatible

Micro Five's Series 5000 is compatible with the IBM PC AT. It features an 8-MHz 16-bit Intel 80286 and 150-nanosecond interleaved memory with no wait states. You can select 6- or 8-MHz 80286 operation. An optional 80287 numeric coprocessor is available.

DMA controllers let the hard-disk subsystem read and write a track of data on a single disk revolution. Average disk-access time is 30 milliseconds.

Available with the Series 5000 are MS-DOS 3.1 and XENIX 3.2, which supports up to 16 users. You can also get GW-BASIC 3.1 and a virtual-disk program.

The Series 5000 Model 100 has 512K bytes of memory, a 1.2-megabyte floppy-disk drive, an RS-232C serial port, a Centronics parallel printer port, a clock/calendar with battery backup, and an AT-compatible keyboard. The Model 200 has the same features plus a 27-megabyte formatted 5¼-inch hard disk. Both models have nine expansion slots.

Options include memory expansion to 2 megabytes on the motherboard and 15 megabytes for the system; disk-drive formatting capacities of 27, 45, 62, or 116 megabytes; 60-megabyte 5¼-inch streaming-tape backup; 360K-byte floppy-disk drive; and up to five three-port I/O cards.

Series 5000 list prices are $3395 for the Model 100 and $5215 for the Model 200. Contact Micro Five Corp., POB 5011, 3560 Hyland Ave., Costa Mesa, CA 92626, (714) 957-1517.
Inquiry 617.

(continued)

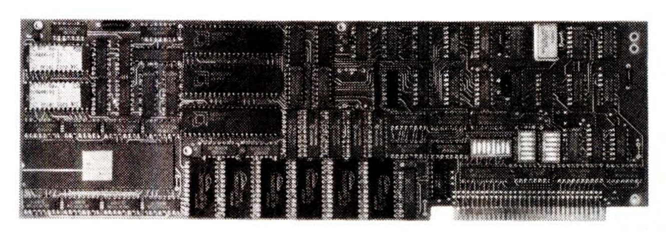
ADD-INS

FFT Coprocessor Card

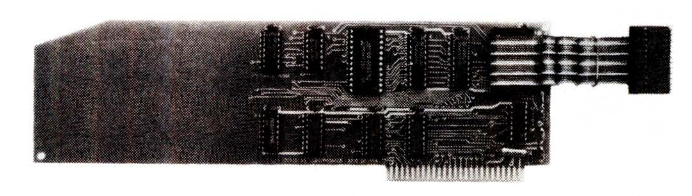
The Ariel PC FFT card performs fast Fourier transforms by executing a single program line in interpreted and compiled BASIC, IBM Pascal and FORTRAN, Lattice C, and Turbo Pascal. The card's disk-based assembly-language driver routines make the host/peripheral interface transparent to the user. PROM-resident algorithms include forward and inverse FFT, hamming window, and power spectral density.

The PC FFT transforms 16-bit integer data arrays of up to 2048 complex points in less than 20 milliseconds. The pipelined architecture lets you fit all the hardware necessary to perform complex signal-processing algorithms inside the computer. The PC FFT's low power consumption lets you install two or more FFT processors in a single host.

The PC FFT card plugs into the IBM PC, XT, AT, or compatible computers and costs $1850. Contact Ariel Corp., Suite 84, 600 West 116th St., New York, NY 10027, (212) 662-7324.
Inquiry **618.**



PC FFT *coprocessor card from Ariel.*



Writable ROM *Board from Douglas Electronics.*

Apple EPROM Programmer

Apparat's Apple 28-pin Prom Blaster is a menu-driven EPROM programmer that will burn the following EPROMs: 2764, 2764A, 27128, 27128A, 27256, 27C256, and 27512.

The Prom Blaster has an edit function for the data buffer and can move system memory into the data buffer. It provides 12½- or 21-volt programming voltage and +5 or +6 volts for V_{CC}.

The Apple 28-pin Prom Blaster is $119. It requires 48K bytes of RAM and one floppy-disk drive. Contact Apparat Inc., 4401 South Tamarac Parkway, Denver, CO 80237, (800) 525-7674; in Colorado, (303) 741-1778.
Inquiry **619.**

Interface Breadboard for IBM, Commodore

Group Technology has put together the BG-Board, an interface breadboard that lets you construct circuits and use BASIC programs to control the flow of information between a microcomputer and external devices. BG-Board provides access to your machine's data, control, and address buses so you can build interfaces for monitoring home appliances, analytical instruments, security systems, and so on.

Interface cards called CableCards let you use the BG-Board with an IBM PC, Commodore 64, or VIC-20. CableCards are also available for the TRS-80 Models I, III, and 4 and the Apple II+ and IIe.

The BG-Board is buffered to protect the microcomputer if a wiring error occurs. It provides up to eight decoded address outputs in either the device- or the memory-addressing models. You can address up to 256 I/O devices by using BASIC software. A built-in logic probe permits detection of logic levels and pulse edges.

The Model BG-101A assembled interface breadboard for the IBM PC, Commodore 64, or VIC-20 sells for $280; the Model BG-101K kit is $205. For more information, contact Group Technology Ltd., POB 87, Route 1 Box 83, Check, VA 24072, (703) 651-3153.
Inquiry **620.**

Apple II Writable ROM

The Writable ROM Board from Douglas Electronics lets an Apple II, II+, or IIe function as a 2K-byte ROM. The board fits into an expansion slot on the Apple and connects to the ROM socket on a destination computer or device with a 12-inch 24-pin jumper cable.

To test a program, you use software to switch the WROM Board to its RAM mode, copy the program to the board, and switch the board back to ROM mode. The destination computer sees the program as on board in ROM. You execute the program by pressing the destination computer's reset button. For further editing, repeat the process. After you debug the program, a ROM is burned.

You can also use the WROM Board to program a 2816A EEPROM. When you program the EEPROM, you can place it in the destination computer's PROM socket, letting the remote machine function independently.

Model 5010-DE-12 Writable ROM Boards are $95. Contact Douglas Electronics Inc., 718 Marina Blvd., San Leandro, CA 94577, (415) 483-8770.
Inquiry **621.**

Single-board 80286 Computer

Transtec Technology's Hydra SBC is based on the Intel iAPX 286 microprocessor. It includes 1 megabyte of on-board RAM expandable to 4 megabytes, from 16K to 256K bytes of ROM, an on-board floppy-disk controller, an SCSI interface, four serial ports, and one bidirectional parallel port. An 80287 numeric coprocessor is optional.

Graphics resolution is as high as 1024 by 768 pixels. Graphics features include panning, smooth scrolling, and programmable character

ADD-INS

sizes or fonts. A 4-color display is standard; with an optional card, you can display 16 colors from a 4096-color palette.

The Hydra SBC's operating system is Concurrent DOS 3.3 with GSX. The board, with 512K bytes of memory and the operating system, sells for $1500. Contact Transtec Technology, Unit 5, Ida Complex, Macken St., Dublin 2, Ireland; tel: 718521/719800.
Inquiry **622.**

Videotaping Graphics Board

New Media Graphics' PC-VideoGraph is an add-on board for the IBM PC, XT, and AT that allows videotaping of computer-generated graphics and text. The PC-VideoGraph has a 6845 microprocessor and 128K bytes of display memory. It runs IBM graphics and text-generation software and operates in a 640- by 400-pixel mode. The board can display 16 colors; with dittering, it can display up to 136 colors simultaneously.

Demonstration software and graphics libraries for BASIC, Pascal, FORTRAN, and C are included. A light pen, mouse, touchscreen, and interactive paint and font software are among PC-VideoGraph's options.

Single-quantity price for PC-VideoGraph is $695. Contact New Media Graphics Corp., 279 Cambridge St., Burlington, MA 01803, (617) 272-8844.
Inquiry **623.**

PERIPHERALS

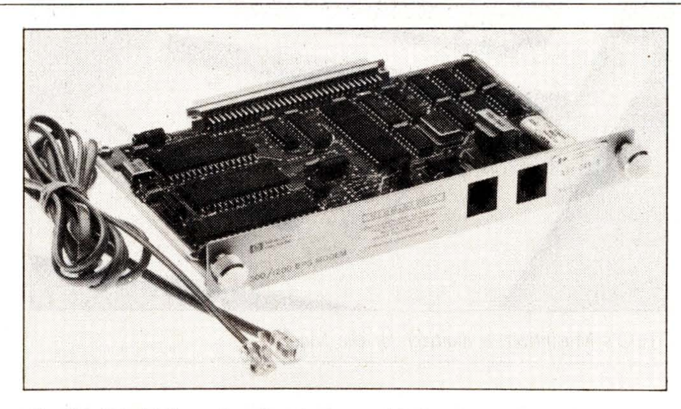
Bus and Modem Support for Integral PC

Hewlett-Packard has introduced two options for its Integral PC: the HP 82904A bus expander and the HP 82915A 300/1200-bps modem.

The bus expander plugs into one of the Integral PC's two I/O ports with a 1-meter cable and expansion interfaces. It has its own power supply and provides five extra ports. Price for the bus expander is $1295.

The serial modem is an asynchronous, full-duplex interface that features auto-dial and auto-answer modes. You install it in one of the Integral PC's I/O ports and can connect it to a telephone network with a standard modular jack. Built-in communications software lets you switch from 300 to 1200 bps, provides auto-dialing, and uses menu-driven configurations. The modem's protocol is UMODEM.

List price for the HP 82915A serial modem is $595. Contact your local Hewlett-Packard dealer or sales office.
Inquiry **624.**



The HP 82915A *modem for the Integral* PC.

MIDI Processor

Hinton Instruments' MIDIC is a MIDI processor that contains its own software in ROM. It has a MIDI 1.0 specified interface with an optoisolator for minimum data corruption and an RS-232C/423-compatible interface for connection to a computer. You can use the computer to select commands from a menu. MIDIC's expansion socket allows for software extensions or custom packages.

The MIDIC 1.1 software has two modes of operation. In the process mode, you can insert MIDIC in the data stream of a MIDI equipment setup and process the data as directed by the setups. All setups can be uploaded and downloaded between MIDIC and a host computer. In the interface mode, MIDIC can buffer and convert MIDI codes in 8-bit binary or ASCII hexadecimal format. Both modes permit automatic generation of active sensing clocks and MIDI timing clocks. Tempo is variable from 30 to 279 crotchets per minute.

MIDIC costs £300; with a battery backup, it is £350. For more information, contact Hinton Instruments, 168 Abingdon Rd., Oxford OX1 4RA, England; tel: Oxford (0865) 721731.
Inquiry **625.**

Portable Battery and Case for Laptops

The Prairie Power portable battery system helps to extend continuous usage of laptop computers. LEDs on the charger indicate when the unit is charging and when the battery is full. The charging unit also allows for emergency power backup.

The battery is a sealed lead-acid unit that has Department of Transportation approval for air transport. Custom cables are included in the package.

Prairie Power's water-resistant carrying case (17 by 13 by 5 inches) features a removable insert panel that you can use as a laptop workstation. It holds the battery, charger, and computer, and it has a padded pocket with room for acoustic cups, cables, a small recorder, or 3½-inch disk drive.

The complete ensemble sells for $169. Components are available separately. Contact Prairie Power Systems Inc., 768 Twelve Oaks Center, 15500 Wayzata Blvd., Wayzata, MN 55391, (800) 435-8721; in Minnesota, (612) 475-1793.
Inquiry **626.**

(continued)

PERIPHERALS

Interface for Home Control

X-10's Powerhouse interface for the Apple IIe and IIc and the Commodore 64 provides automatic control of electrical devices in the home. It has its own 80C48 processor, on-board ROM, RAM chip, and real-time clock. Its battery backup can sustain the unit without AC power for more than 100 hours. X-10 Powerhouse sends signals over AC wiring to control up to 72 lights and appliances plugged into System X-10 modules, which are plugged into 120-volt outlets.

The interface comes with a home-control software package that uses a color-graphics interactive approach to programming. After you complete installation and programming, you can disconnect the Powerhouse from the computer. The interface will continue to run the control system according to the program.

The X-10 Powerhouse (interface, software, and connecting cable) retails for about $120. Contact X-10 Inc., 185A Legrand Ave., Northvale, NJ 07647, (201) 784-9700.

Inquiry **627.**

RS-232C to IEEE-488 Controller

The CmC RG interface lets any personal computer control the IEEE-488 bus. You can connect up to 15 IEEE-488 devices to one RS-232C port by using the interface. In the CmC RG's transparent mode, an IEEE-488 device looks like an RS-232C device to the computer.



GTCO's Macintizer, a digitizer for the Mac.

You can configure this interface for talk and listen commands for all primary and secondary addresses. You can also use a talk-only mode with any listen-only device. The CmC RG understands simple ASCII commands and works with any computer language.

The CmC RG comes with case, power supply, and standard IEEE-488 and RS-232C connectors. The RG4 is for device number 4 only and costs $495; the RGA supports devices 0 to 30 and costs $695. Contact Connecticut microComputer, POB 186, Brookfield, CT 06804, (203) 354-9395.

Inquiry **628.**

Macintosh Digitizer

The Macintizer from GTCO Corp. plugs directly into the Macintosh's mouse port and operates without any modification to the Mac's operating system or applications software. GTCO says this electromagnetic digitizer requires no preventive maintenance and will not skip (as a mouse can). It consists of an electronic work surface and a hand-held stylus.

The Macintizer works in an absolute coordinate mode, so pointing to the center of the tablet always puts the arrow in the center of the screen. You can use the digitizer to trace maps, drawings, and other nonmetallic material. The Macintizer's surface has two work areas that provide a one-to-one screen correspondence and a 33 percent reduction. An optional mouse cable is available.

The Macintizer sells for $599. Contact GTCO Corp., 1055 First St., Rockville, MD 20850, (301) 279-9550.

Inquiry **629.**

IBM PC Memory Machine

Peachtree Technology's Memory Machine for the IBM PC is an external dual-drive subsystem that resides between the PC and its monitor. You can choose from several combinations of disk drives, including 5¼-inch Winchester drives, removable Winchester cartridge drives, and backup tape-drive systems. Various configurations provide up to 20 megabytes of fixed-drive and 60 megabytes of tape-drive capacity.

The Memory Machine contains a power supply, cooling fan, overload power-surge protector, and multifunction power director. Its five front-panel power switches and 15-amp three-prong connectors let you supply power to five other peripherals.

Sold as a kit, the Memory Machine's two drives, cables, and instructions cost $3695. Contact Peachtree Technology Inc., 3020 Business Park Dr., Norcross, GA 30071, (404) 662-5158.

Inquiry **630.**

SOFTWARE • APPLE

Musical Speech System

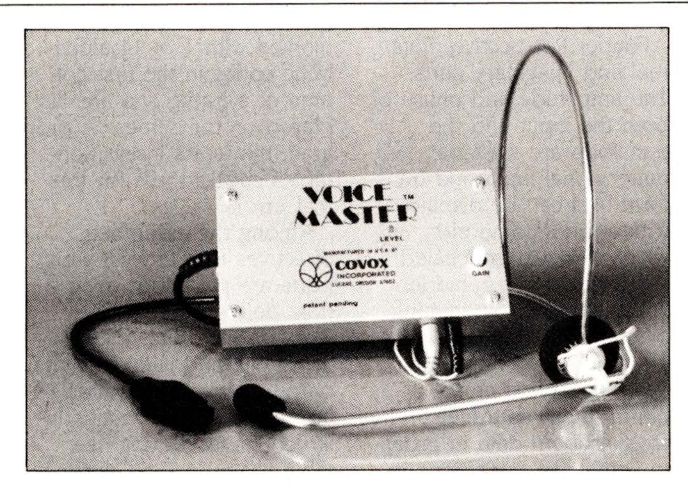
The Voice Master is a digital speech/voice recognition system for the Apple II line, Commodore 64, or Commodore 128. But it's also a music-synthesis program that converts humming and whistling into a music score. The package consists of a hardware module, a headset/microphone, system software, and cables.

The system basically works as a digital tape machine, recording the user's voice as digital information and storing it in vocabulary files on a disk. Each file can contain up to 64 distinct words, sounds, or phrases. The user can control the recording rate, playback speed, and volume.

The accompanying Voice Harp program lets you compose music in real time by humming or whistling; it converts your vocal input into musical output. As you hum or whistle notes, they scroll by on the display in standard musical notation. In editing mode, you can play back and rearrange or change notes. In performance mode, you can change octaves and add chords. When you finish, you can save your composition and print out the score.

The Voice Master costs $89.95. Sound Master, an optional plug-in card for the Apple II+ and IIe, provides three-part harmony and sound effects; it costs $39.95. A Voice Master for the Atari 800XL, 65XE, and 130XE reportedly will be available soon. Contact Covox Inc., 675-D Conger St., Eugene, OR 97402, (503) 342-1271.

Inquiry **631.**



Covox's speech system for Apple IIs and Commodores.

Knowledge Integration Toolkit

MacKIT Level 1, a program for the 512K-byte Macintosh, is designed to serve as an introduction to knowledge engineering and help you build expert systems. It features a backward-chaining inference engine, a production rule compiler, a question generator, and a graphics window.

You code your pertinent knowledge into production rules using English and a word processor (MacWrite will do). Employing a back-chaining method, MacKIT starts with conclusions, finds rules that support the conclusions, and tries to verify the premise by searching the knowledge base for relevant facts. The process continues until the conclusions are verified or disproved.

MacKIT is written in MacFORTH. It costs $149. Contact Knowledge System Environments Inc., 201 South York Rd., Dillsburg, PA 17019, (717) 766-4496.

Inquiry **632.**

Expert-Systems Building Tool for Mac

ExperTelligence has developed a microcomputer version of OPS5, a tool for building expert systems. ExperOPS5 runs on the 512K-byte Macintosh and features a forward-chaining inference engine coupled with a pattern-matching algorithm. It also has an interface designed to provide complete access to ExperLisp, the vendor's LISP development environment for the Mac.

ExperOPS5 has a suggested retail price of $325 and requires an add-on floppy-disk or hard-disk drive and ExperLisp software ($495). Contact ExperTelligence Inc., 559 San Ysidro Rd., Santa Barbara, CA 93108, (805) 969-7874.

Inquiry **633.**

Mac Meets Juki

Juki's LetterPrint kit gives Macintosh users the option of sending output to Juki 6100 and 6300 letter-quality printers. The software is capable of driving MacWrite word-processing functions directly onto the Juki printer.

The kit contains a disk and instructions. It has a suggested retail price of $75. A connector cable costs $20 more. Contact Juki Office Machine Corp., Printer Division, 299 Market St., Saddle Brook, NJ 07662, (800) 932-0590; West Coast, (800) 325-6134; in California, (800) 435-6315.

Inquiry **634.**

Alternatives for Iconoclasts

PBI Software's Icon Switcher lets you alter Macintosh icons or fashion ones of your own design. The program comes with 20 icons and a tutorial and has a suggested retail price of $19.99.

PBI sells additional sets of icons at $19.99 each. Icon Library #1 is a collection of business and utilities images. Icon Library #2 consists of "fun and games" icons. Icon Switcher can change the images in both libraries.

Contact PBI Software Inc., 1155B-H Chess Dr., Foster City, CA 94404, (415) 349-8765.

Inquiry **635.**

Spelling Checker for Appleworks

Spellworks proofreads documents prepared with the Appleworks word-processing program. It has a 90,000-word dictionary and checks spelling at a rate of 10 words per second.

The spelling checker retails for $49.95. Contact Advanced Logic Systems Inc., 1195 East Arques Ave., Sunnyvale, CA 94086, (408) 730-0306.

Inquiry **636.**

(continued)

SOFTWARE • IBM PC

Scientific Subroutine Library

Wiley Professional Software's BASICA Library consists of 114 pretested and precompiled mathematical and statistical subroutines. The subroutines perform tasks involving the most commonly used complex number operations in such areas as matrices with real or complex elements, polynomials, differential equations, analysis of variance, solution of equations, and general statistics.

BASICA Library comes on three disks containing source code, compressed source code, and test programs and results. System requirements are an IBM PC, XT, AT, or compatible with at least 128K bytes, a double-sided disk drive, and PC-DOS or MS-DOS 1.1 or later. The price is $125. Contact Wiley Professional Software, John Wiley & Sons Inc., 605 Third Ave., New York, NY 10158, (212) 850-6788.

Inquiry 637.

Fourier Transforms with Graphics

Alligator Transforms has released a package that performs one- and two-dimensional Fourier transforms and displays the results graphically. Fourier Perspective can handle one-dimensional real or complex data sets up to 8192 points and two-dimensional arrays as large as 128 by 128. Reported typical times are 0.5 seconds for a 256-point 1-D transform and 11 seconds for a 64 by 64 2-D transform with an 8087 math coprocessor. The program can also plot individual rows.

Fourier Perspective plots real and imaginary parts. The amplitude and phase of both the input and the transform are available. Two-dimensional input and transform files can be displayed with a hidden line plot, which removes concealed segments, or a nonhidden line plot. No programming or compiling is necessary. The package contains utilities that let you create arbitrary input data files and checkerboard data in order to center the transforms in the frequency domain.

The software runs on the IBM PC, XT, AT, and compatibles and requires DOS 2.0 or later, at least 192K bytes of memory, two disk drives, and a graphics card. Options are a screen-dump utility and an 8087 math coprocessor. List price is $99. Contact Alligator Transforms, POB 271505, Houston, TX 77277, (713) 665-3855.

Inquiry 638.

Table-based Cross-Assembler

Cross-8 from Universal Cross-Assemblers uses a flexible instruction-table structure to produce code for most microprocessors and microcontrollers with an 8-bit data word and an address word of 16 bits or less. You can specify the format of the hexadecimal machine-language file as Intel, Motorola, or Tektronix 8-bit format.

You can prepare the assembly-language source file using any ASCII text editor. Cross-8 ignores the most-significant bit of all ASCII characters. It selects the corresponding processor instruction file by using the CPU directive within the source code.

Assembly errors are marked with 1 of 14 alphabetic codes in the first column of a listing and are displayed on the screen. A program that sorts instruction tables checks them for format errors.

Among the assembler directives that Cross-8 supports are processor declaration; define byte, data storage, and word; end of assembly; and hexadecimal output format declaration. A 30-page manual contains instructions for writing new tables or modifying existing ones.

Cross-8 is about 25K bytes long and requires 17 bytes per label and 35 bytes for each instruction in the table. For IBM PCs and compatibles with PC-DOS and MS-DOS 2.0 (or higher), at least 128K bytes of RAM is recommended; an Apple II+ or IIe with CP/M-80 needs at least 48K bytes. The program costs $99.95 in U.S. funds and $129.95 in Canadian. Contact Universal Cross-Assemblers, POB 384, Bedford, Nova Scotia B4A 2X3, Canada.

Inquiry 639.

Software Emulates Intel 8051 Family

HiTech Equipment's 8051SIM emulates Intel's 8051 family of microprocessors and provides some of the debug and test facilities of an in-circuit emulator. The menu-driven program accepts Intel .HEX files and features a "hex calculator" mode.

You initiate a typical session after the assembly of an 8051 program by invoking the emulator with the name of the object file. The display is formatted as several windows into the central processor, and the main menu is displayed. You can single-step or trace (with breakpoints) your program while watching the effects on the screen.

The package is available for IBM PC XTs with PC-DOS and Z80 machines with CP/M for $199. Contact HiTech Equipment Corp., 9560 Black Mountain Rd., San Diego, CA 92126, (619) 566-1892.

Inquiry 640.

BASIC Matrix Commands

Designed to enhance BASIC on the IBM PC, Matrix 100 provides matrix-manipulation capabilities that you can call with a single statement for each operation. Besides the standard operations, the package has commands to invert matrices, solve equations, perform multiple regression, and obtain LU and QR factors.

Matrix 100 also has source code for an interactive linear programming package and an eigenvalue solver for real symmetric matrices.

According to Stanford Business Software, its program calculates up to 100 times faster than BASIC. In double precision, Matrix 100 with the optional 8087 support is reportedly 25 times faster than the standard package.

Matrix 100 runs on any IBM PC with BASIC or BASICA and at least 128K bytes of RAM (192K bytes is recommended). It costs $80. With 8087 support, it costs $125. Additional compiler support raises the price to $250. Contact Stanford Business Software Inc., Suite 215, 4151 Middlefield Rd., Palo Alto, CA 94303, (415) 424-9499.

Inquiry 641.

SOFTWARE • OTHER COMPUTERS

Locus of Root Solver

Locipro provides control-system and electronic engineers with a means of quickly determining closed-loop system stability from open-loop transfer functions. The stand-alone program solves the locus of roots for systems up to the 26th order and 10 loop elements.

Output data can be vectored to a line printer or to data files. All program inputs are free-format and menu-driven.

Locipro, priced at $72.95, is available for PC-DOS, MS-DOS, CP/M-80, and TRSDOS machines in 121 different disk formats. Contact BV Engineering, Suite 207, 2200 Business Way, Riverside, CA 92501, (714) 781-0252.
Inquiry **642.**

Cross-Reference Generator

Dalsoft Engineering has developed a cross-reference generator that's designed to work with most programming languages. UCRF comes with configuration files for BASIC, C, Pascal, Modula-2, FORTRAN, COBOL, IBM Macro Assembler, and dBASE II. You can modify these files to accommodate specific language implementations or develop new files to support other languages.

UCRF accepts multiple input files from anywhere on disk and produces program and cross-reference listings with page numbers, user-defined title lines, and date and time stamp. Full directory and path support are provided for input and output.

The program can be operated either from the DOS command line or activated from batch files to automate the compilation/assembly and listing of groups of program modules. UCRF handles symbol lengths of up to 128 characters and automatically folds long input lines.

Minimum system requirements are 128K bytes of RAM, one disk drive, and PC-DOS 2.0 or higher. UCRF costs $39.95. Contact Dalsoft Engineering, 3565 High Vista, Dallas, TX 75234, (214) 247-7695.
Inquiry **643.**

Low-Cost Video Digitizer

A video-digitizer system for the TRS-80 Color Computer and the Commodore 64 uses a composite standard NTSC video-input source—a video camera, video-cassette recorder, or videodisc player—to construct gray-level images in less than 5 seconds. The package, consisting of software, assembly plans, documentation, and a blank printed circuit board, costs $39.95. You must supply the other components.

The Color Computer version provides a resolution of 256 by 192 pixels in selectable gray levels of three, five, or seven shades. The joystick and cassette ports are used for interfacing.

The Commodore 64 version provides resolution of 160 by 200 pixels with gray levels of four, six, or eight shades. Interface is via the user I/O port.

Both versions are menu-driven. Brightness and contrast are adjustable.

Contact Kinney Software, Dept. B, 121 North Hampton Rd., Donnelsville, OH 45319, (513) 882-6527.
Inquiry **644.**

Design Tool for 68000, 68008

Orion Instruments has developed a disassembler/debugger program for products based on Motorola's 68000 and 68008. The package, called DDB68K, runs on Orion's Universal Development Laboratory (UDL).

UDL is a compact development system that integrates a 48-channel bus-state analyzer, an 8-bit and a 16-bit real-time emulator, an EPROM programmer, and a stimulus generator. The system interfaces with any MS-DOS or CP/M machine and enables software and hardware debugging of more than 30 processors.

DDB68K augments the trace-analyzer features of UDL with multiple breakpoints and single-step capabilities. Hexadecimal or binary files can be directly downloaded into the internal emulation memory of UDL. The software permits the execution of a program from emulated memory or target-system memory (RAM or ROM) with the capability of memory patching.

The internal registers of a processor can be displayed or modified. A debugged program can be stored on disk or burned directly into an EPROM. The standard UDL supports operation of the 68000 up to 10 MHz; optionally, it can support up to 13 MHz.

DDB68K costs $395. The standard UDL is $2995. Contact Orion Instruments Inc., 6th Floor, 702 Marshall St., Redwood City, CA 94063, (415) 361-8883.
Inquiry **645.**

LISP Interpreter

CLISP is a LISP interpreter written in C and running on MS-DOS systems. It has more than 40 built-in functions for list manipulation, arithmetic, and relational and Boolean operations. The package contains what Westcomp calls a "modest" library of LISP functions.

Complete source code for the interpreter is included (C86 by Computer Innovations was the compiler used). With the information in the manual, a user can add in almost any combination of functions, windows, graphics, and so on.

The package costs $150 and consists of documentation, CLISP source code, run-time program, and LISP routines. Contact Westcomp, Suite 229, 517 North Mountain Ave., Upland, CA 91786-5016, (714) 982-1738.
Inquiry **646.** ■

—Compiled by Dennis Barker and Lynne M. Nadeau

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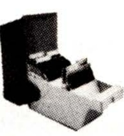
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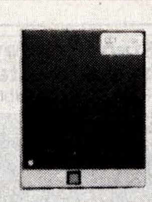
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MFREE	- displays next available and total available memory
MOVE	- renames file(s) into another directory
TAIL	- displays last lines in file
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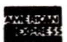
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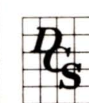
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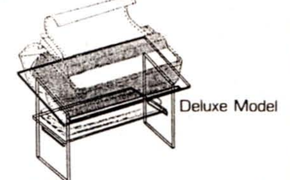
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Two years ago, if you'd told me I'd be writing this ad, I would have laughed.

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Just saying that quality control was poor would be charitable.

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That was yesterday.

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...and are simply the best value in diskettes available today.

The torture test.

Considering Wabash's earlier dubious reputation, I wasn't exactly a true believer when their Director of Marketing came into my office with samples.

So I took a box at random, selected a disk, bent the thing every which way and slipped it into my IBM-PC.

It formatted. It booted. It stored and retrieved data.

That wasn't enough.

I gave samples of the diskettes to Curt Rostenbach and, in turn, to Tom Streit, both hackers of long experience and members of the Waukegan (Illinois) Apple Users Group.

Tom really went at it.

He took a quartz-halogen lamp, aimed it at the diskette until it started to smoke (and melt)...and then formatted, booted the diskette and stored and retrieved data!

The same terribly (and intentionally) mutilated diskette ran on an ITT, Corona and IBM.

Curt was nicer.

He simply bent the diskette every which way...and it still formatted, booted and ran on his Apple.

The best buy I've ever seen.

DISK WORLD!, Inc. sells more flexible magnetic media by mail-order than anyone else in the world.

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I also don't like companies who try to milk a "quality" or "premium" image for a higher price like Dysan and Verbatim did...until they failed.

As President of DISK WORLD!, Inc., my motto is simple: "the best diskette for the least amount of money."

Wabash is it.

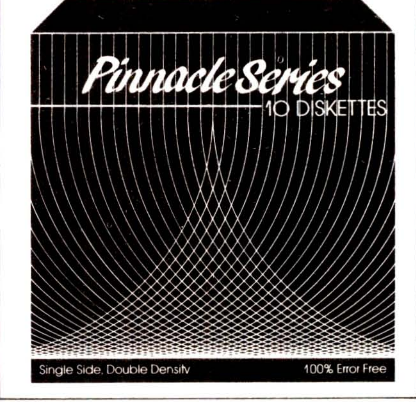
Right now, there is no better value than the Wabash Pinnacle Series of diskettes.

Granted, you have to buy a hundred at a time, but so what? Split the order with friends, relatives, co-workers or even your worst enemies.

The key thing is to get the most diskette for the money.

And this is it.

(Incidentally, as a corporation, we put our money where our



mouth is. Our first order for Wabash Pinnacle Diskettes was 1.5-million units.)

That's an awful lot of faith and confidence.

But, then again, I have the diskette that Tom Streit literally melted...and kept on running.

The truth about $1.00 or less diskettes.

More and more ads are popping up offering diskettes for $1.00 or less.

By the same token, more and more people who were selling used cars a few months ago are now selling diskettes by mail.

We did a little survey of current ads for diskettes advertised for a dollar or less and did some analysis of the market and here's what we found as it applies to 5.25″ DSDD diskettes "supposedly" selling for a dollar or less.

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Computer Club	.95 ea.	.98 ea.	Unspecified.
	.99 ea.	1.02 ea.	Unspecified.
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Precision Data	.89 ea.	.93 ea.	Unspecified.
Diskette Connec.	.93 ea.	.93 ea.	Unspecified.
Comp Soft Serv.	.77 ea.	.77 ea. + shpg.	Unspecified.
Computer/Computer	.99 ea.	.99 ea.	Unspecified.
DISK WORLD	.89 ea.	.92 ea.	Wabash Datatech

The real truth about $1.00 or less diskettes.

It costs all diskette manufacturers about the same to produce a diskette. Some may charge more because they want to project a "premium quality" image, ala the late, lamented Dysan who bought their basic media from 3M.

Some charge less because they sell a sub-standard product...and we're not foolish enough to name names here.

But here's the truth about the $1.00 or less diskette market.

It falls into four categories:

1. The DISK WORLD's of the universe who simply are so big that they can buy first quality product in massive quantities and choose to pass on the savings to you. (Precision Data and Diskette Connection on **BRAND NAME** products also fall into this category.)

2. The people who buy "cosmos"...stuff from major manufacturers that usually hits quality control standards, but is cosmetically blemished and thus can't be packaged and sold under the manufacturer's own name.

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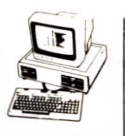
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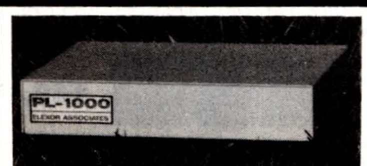
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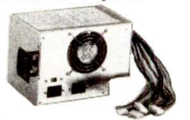
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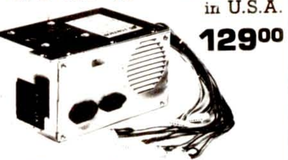


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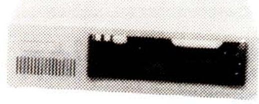
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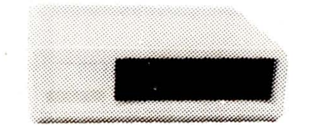
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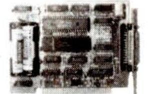
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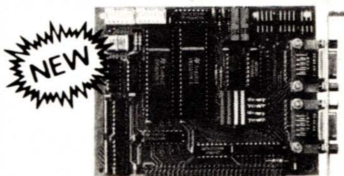
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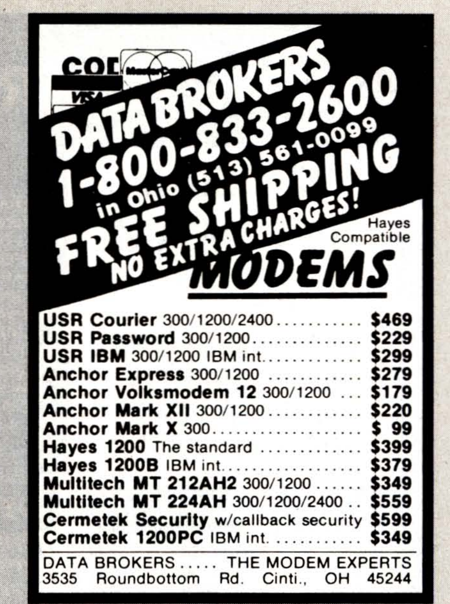
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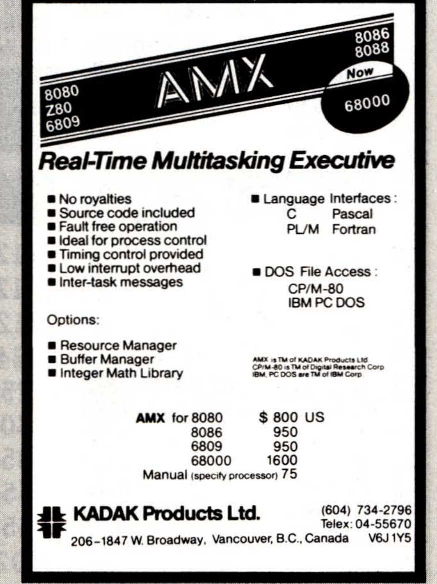
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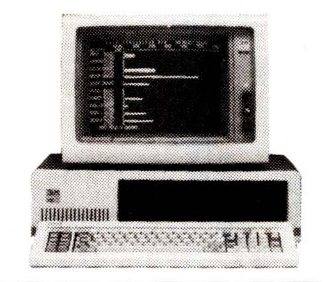
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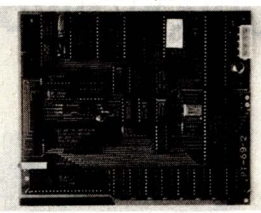
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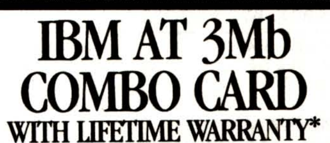


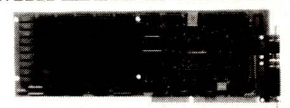
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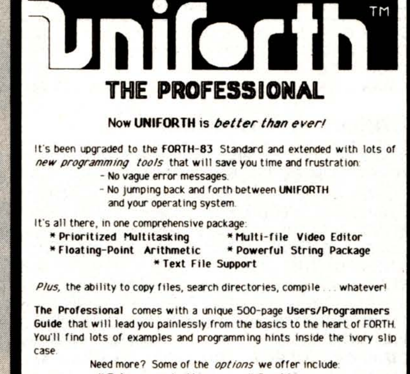
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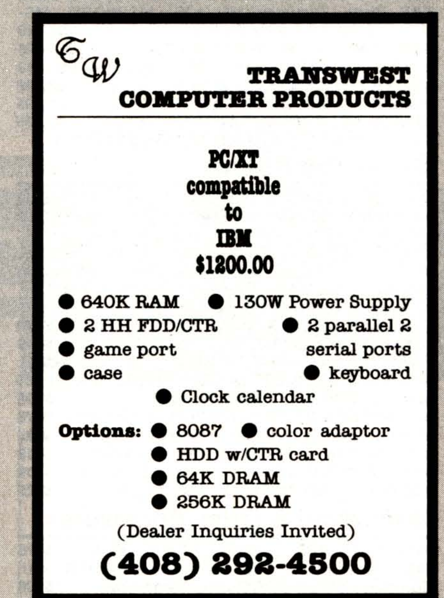
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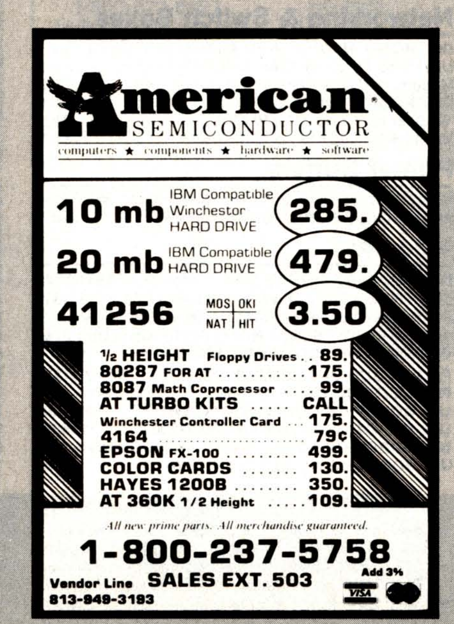
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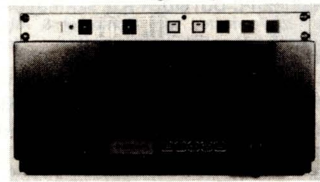
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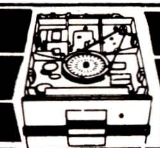
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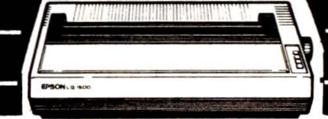
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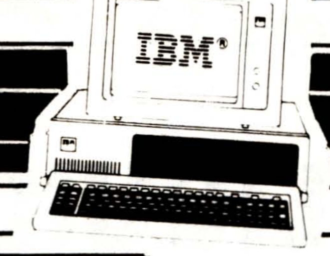
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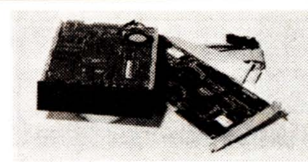


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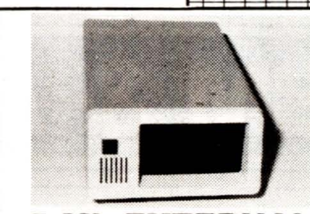
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S-100 ST	$3.95	$3.25
S-100 WW	4.75	4.10
44 Pin ST	2.75	2.60
44 Pin WW	4.75	4.25
72 Pin ST	6.50	6.10
72 Pin WW	7.25	6.95

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	1-24	25
DB25S (Female	$3.10	$2.90
DB25P (Male)	2.40	2.29
Hood $1.25	Mtg H/W $ .99	
DE37S (Female)	$5.95	$5.75
DE37P (Male)	5.25	5.10
Hood $1.75	Mtg H/W $ .99	
DD50S (Female)	$8.95	$8.65
DD50P (Male)	6.00	5.75
Hood $3.25	Mtg H/W $ .99	

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IDC 36 Pin Female	9.49
Solder 36 Pin Male	7.49
Solder 36 Pin Female	8.95

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IDC CONNECTORS

IDC TYPE	ACP NO	NUMBER OF CONTACTS 10	20	26	34	40	50
Solder Header	IDHxxS	.79	1.20	1.65	2.10	2.40	3.00
Rt Angle Solder Header	IDHxxSR	.79	1.20	1.65	2.10	2.40	3.00
Ribbon Header Socket	IDSxx	.75	.95	1.35	1.50	1.85	2.10
Ribbon Header	IDMxx	—	5.25	5.95	6.75	7.25	8.25
Ribbon Edgecard	IDExx	1.70	2.15	2.50	2.60	3.70	3.95
Wirewrap Header	IDHxxW	1.80	2.90	3.75	4.25	4.95	6.50
Rt Angle W/W Header	IDHxxWR	1.99	3.10	4.10	4.20	4.60	7.15

NOTE: To order insert number of contacts in place of xx in ACP part number.
ORDER QUANTITY OF 50pcs (mixed) AND TAKE AN ADDITTIONAL 10% OFF.

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Okidata 84 (200cps, Serial)	949.00
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Tractor for Okidata 92	54.00
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2K Serial Board for Okidata 92/93	99.00
Extra Ribbon	5.00

6800

68000	$19.95	6810	$ 2.85	6850	$ 3.25
68000L10	39.95	6820	3.75	6852	5.65
6800	2.90	6821	2.90	6860	7.90
6802	7.75	6828	14.50	6875	6.75
6803	18.95	6840	12.75	6880	2.20
6809E	9.50	6845	11.95	68047	22.95

6500

6502	$4.50	6504	$6.75	6522	$5.25
6502A	6.90	6507	9.75	6532	9.50
6502B	9.50	6520	4.25	6551	11.50

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8039	5.75	8216	1.95	8271	69.95
8080A	2.95	8224	2.20	8275	26.95
8085A	4.90	8226	1.95	8279	8.75
80C85A	9.95	8228	3.40	8282	6.25
8086	24.50	8237	13.75	8283	6.25
8087-2	129.95	8237-5	15.95	8284	5.50
8088	17.50	8238	4.25	8286	6.45
8089	88.95	8243	3.95	8287	6.45
8155	6.75	8250	10.50	8288	11.95
8156	6.75	8251	4.25	8289	44.95
8185	26.95	8251A	5.95	8292	12.95
8202	23.95	8253	6.75	8741	27.95
8203	37.95	8255	4.25	8748	24.50
8205	3.25	8255A	5.95	8749	24.50
8212	1.95	8257	5.75	8755A	34.95

Z-80

	2.5MHz	"A" 4.0MHz	"B" 6.0MHz
Z80-CPU	2.25	2.75	6.95
Z80-CTC	2.50	3.75	9.25
Z80-DART	7.50	8.50	17.95
Z80-DMA	8.00	8.95	17.95
Z80-PIO	2.95	3.50	9.50
Z80-SIO/0	8.50	9.50	22.95
Z80-SIO/1	8.50	9.50	—
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Z8030	$34.95	Z8001	$34.95	Z6132	$32.95
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1791	22.75	2793	32.95	1691	6.95
1793	21.50	2795	32.95	2143	6.95
1795	21.50	2797	27.95	9216	12.95

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1013A	3.95	8250	10.50	TMS5501	14.95
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2758 (5V)	5.50	2732A-2 (200nS)	8.95
2716 (450nS)	3.75	2764 (450nS)	4.50
2716 (350nS)	5.50	2764 (250nS)	6.50
2516 (5V)	5.50	2764 (200nS)	8.50
TMS2716	7.50	TMS2564 (450nS)	9.95
TMS2532	5.60	MCM68764 (450nS)	19.95
2732 (450nS)	4.60	MCM68766 (350nS)	21.95
2732 (250nS)	6.00	27128-3 (300nS)	9.50
2732 (200nS)	8.00	27128 (250nS)	15.95
CMOS EPROMS		27C32	$9.95
27C16	$8.95	27C64	12.95

STATIC RAMS

2101 (450nS)	$1.89	MK4118	$4.95
21L02 (450nS)	.99	TMM2016-2 (200nS)	3.10
2102-1 (450nS)	.79	TMM2016-15 (150n)	3.95
21L02-2 (250nS)	1.39	TMM2016-1 (100nS)	3.00
2111 (450nS)	2.75	HM6116P-4 (200nS)	4.75
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2114 (450nS)	1.45 8/9.50	HM6116P-2 (120nS)	5.75
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4002	.22	4030	.39	4066	.39	4507	1.10
4006	.79	4031	3.25	4069	.28	4508	1.90
4007	.22	4032	2.15	4070	.35	4510	.79
4008	.95	4034	1.91	4071	.28	4511	.79
4009	.39	4035	.79	4072	.28	4512	.79
4010	.39	4037	1.95	4073	.28	4514	1.18
4011	.24	4040	.75	4075	.28	4515	1.79
4012	.24	4041	.75	4076	.75	4516	1.19
4013	.35	4042	.65	4077	.35	4518	.85
4014	.75	4043	.85	4078	.35	4520	.75
4015	.39	4044	.69	4081	.29	4555	.95
4016	.35	4046	.80	4082	.29	4556	.95
4017	.65	4047	.89	4085	.95	4566	1.35
4018	.79	4048	.99	4086	.95	80C95	1.50
4019	.39	4049	.35	4093	.45	80C97	.49
4020	.69	4050	.34	4094	2.95	MC14408	12.95
4021	.69	4051	.75	4098	1.90	MC14409	12.95
4022	.69	4052	.75	4099	1.85	MC14410	9.95
4023	.25	4053	.75	4501	.69	MC14411	11.95
4024	.59	4055	3.95	4502	.95	MC14412	12.95
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4027	.45						

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LM311CN	.62	LM733	.98	CA3023	2.75
LM312H	1.75	LM739	1.85	CA3039	1.25
LM318CN	1.45	LM741CN	.33	CA3046	1.25
LM318H	1.55	LM741H	.40	CA3059	2.85
LM319N	1.19	LM741N	.29	CA3060	2.85
LM320 (see VRs)		LM747	.65	CA3065	1.69
LM324N	.55	LM748	.55	CA3080	1.10
LM339N	.95	LM1014	1.15	CA3081	1.60
LM340 (see VRs)		LM1303	1.90	CA3082	1.60
LM348N	.95	LM1310	1.45	CA3083	1.55
LM358CN	.65	MC1330	1.65	CA3086	.80
LM359	1.75	MC1349	1.85	CA3089	2.95
LM360N	2.95	MC1350	1.15	CA3096	3.45
LM370N	4.95	MC1358	1.65	CA3130	1.29
LM373N	3.95	MC1372	6.75	CA3140	1.15
LM376N	3.75	LM1414	1.55	CA3146	1.79
LM377N	1.90	LM1558H	2.99	CA3160	1.49
LM380CN	.85	LM1800	2.35	LM13080	1.25
LM380N	1.05	LM1812	8.10	LM13600	1.45
LM381N	1.59	LM1830	3.40	LM13700	1.45
LM382N	1.35	LM1871	5.45	LF347	2.19
LM383N	1.95	LM1872	5.45	LF351	.60
LM384N	1.75	LM1877	3.20	LF353	.99
LM386N	.89	LM1889	1.90	LF355	1.10
LM387N	1.29	LM1896	1.70	LF356	1.10
LM389N	1.15	ULN2001	1.95	LF357	1.39
LM392N	.69	ULN2003	1.49	TL071CP	.79
LM723N	.48	XR2206	3.75	TL072CP	1.35
LM723H	.55	XR2207	2.90	TL074CN	1.90
NE531	2.85	XR2208	2.40	TL081CP	.59
NE555	.35	XR2211	3.75	TL084CN	1.90
NE556	.65	LM2877P	2.00	TL494	4.10
NE558	1.49	LM2878P	2.25	TL496	1.65
NE561	23.50	LM2900	.83	TL497	3.20
NE564	2.85	LM2901	.99	MC3423	1.49
LM565	.95	LM2903	.69	MC3453	4.95
LM566	1.45	LM2907	2.45	MC3456	1.29
LM567	.85	LM2917	2.85	MC3459	3.75
NE570	3.85	LM3900	.55	MC3469	5.25
NE571	2.90	LM3905	1.15	MC3470	7.95

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78L05, 12, 15V	.65	79L05, 12, 15V	.75
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78MG/79MG	1.49	LM317H/K	1.25/3.85
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7805K Also 12, 15, 24V	1.29	LM337K	3.75
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7401	.18	7447	.65	74125	.42	74177	.69
7402	.18	7448	.68	74126	.44	74179	1.34
7403	.18	7450	.19	74128	.49	74180	.75
7404	.18	7451	.19	74132	.45	74181	1.75
7405	.23	7453	.19	74136	.75	74182	1.15
7406	.49	7454	.19	74141	.85	74184	2.25
7407	.49	7459	.25	74142	2.95	74185	2.25
7408	.24	7460	.37	74143	3.70	74190	.67
7409	.19	7470	.29	74144	2.95	74191	.67
7410	.19	7472	.29	74145	.59	74192	.67
7411	.24	7473	.33	74147	1.49	74193	.67
7412	.38	7474	.34	74148	1.19	74194	.67
7413	.34	7475	.38	74150	1.09	74195	.67
7414	.49	7476	.34	74151	.55	74196	.75
7416	.49	7479	4.60	74152	.67	74197	.86
7417	.49	7480	.69	74153	.53	74198	1.15
7420	.19	7482	.95	74154	1.19	74199	1.15
7421	.35	7483	.45	74155	.69	74221	1.19
7422	.45	7485	.55	74156	.59	74251	.75
7423	.58	7486	.35	74157	.59	74273	1.65
7425	.29	7489	1.95	74158	1.65	74276	1.89
7426	.29	7490	.35	74159	1.58	74279	.75
7427	.25	7491	.65	74160	.79	74283	1.40
7428	.55	7492	.45	74161	.69	74284	2.90
7430	.18	7493	.35	74162	.69	74285	2.90
7432	.29	7494	.85	74163	.69	74290	1.49
7437	.25	7495	.50	74164	.69	74298	1.49
7438	.29	7496	.69	74165	.69	74365	.55
7439	.58	7497	2.70	74166	.85	74366	.55
7440	.19	74100	1.50	74167	2.75	74367	.55
7441	.79	74107	.24	74170	1.25	74368	.55
7442	.45	74109	.37	74172	4.75	74390	1.45
7443	1.15	74116	1.45	74173	.69	74393	1.33
7444	1.15	74121	.29	74174	.69	74490	2.25
7445	.68	74122	.44	74175	.69		

74LS00

74LS00	$ .22	74LS113	$ .38	74LS247	$ .74
74LS01	.22	74LS114	.39	74LS248	.98
74LS02	.22	74LS122	.45	74LS249	.98
74LS03	.22	74LS123	.95	74LS251	.59
74LS04	.24	74LS124	2.75	74LS253	.59
74LS05	.25	74LS125	.49	74LS257	.59
74LS08	.27	74LS126	.49	74LS258	.59
74LS09	.28	74LS132	.59	74LS259	2.95
74LS10	.25	74LS136	.39	74LS260	.59
74LS11	.33	74LS138	.59	74LS261	2.49
74LS12	.33	74LS139	.59	74LS266	.55
74LS13	.39	74LS145	1.19	74LS273	1.45
74LS14	.59	74LS148	1.38	74LS275	3.29
74LS15	.33	74LS151	.55	74LS279	.59
74LS20	.26	74LS153	.55	74LS283	.68
74LS21	.29	74LS154	1.49	74LS290	.88
74LS22	.29	74LS155	.69	74LS293	.78
74LS26	.29	74LS156	.69	74LS295	.98
74LS27	.29	74LS157	.69	74LS298	.88
74LS28	.29	74LS158	.69	74LS324	1.75
74LS30	.25	74LS160	.69	74LS347	1.95
74LS32	.33	74LS161	.69	74LS348	1.95
74LS33	.53	74LS162	.69	74LS352	1.25
74LS37	.35	74LS163	.69	74LS353	1.25
74LS38	.39	74LS164	.69	74LS363	1.29
74LS40	.25	74LS165	.90	74LS365	.48
74LS42	.44	74LS166	1.90	74LS366	.48
74LS47	.74	74LS168	1.15	74LS367	.45
74LS48	.74	74LS169	1.15	74LS368	.45
74LS51	.25	74LS170	1.40	74LS373	1.39
74LS54	.29	74LS173	.67	74LS374	1.33
74LS55	.29	74LS174	.67	74LS375	.69
74LS73	.39	74LS175	.67	74LS377	1.38
74LS74	.34	74LS181	1.95	74LS385	1.95
74LS75	.39	74LS190	.85	74LS386	.45
74LS76	.39	74LS191	.85	74LS390	1.15
74LS78	.39	74LS192	.78	74LS393	1.15
74LS83	.59	74LS193	.78	74LS395	1.15
74LS85	.69	74LS194	.69	74LS399	1.47
74LS86	.39	74LS195	.69	74LS424	2.95
74LS90	.54	74LS196	.79	74LS668	1.75
74LS92	.54	74LS197	.79	74LS670	2.29
74LS93	.54	74LS221	.89	81LS95	1.45
74LS95	.75	74LS240	.95	81LS96	1.45
74LS96	.89	74LS242	.95	81LS97	1.45
74LS107	.39	74LS243	.95	81LS98	1.45
74LS109	.39	74LS244	1.25	25LS2521	2.65
74LS112	.39	74LS245	1.45	25LS2569	3.50

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74S09	.39	74S124	2.69	74S194	1.49	74S387*	1.95
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74LS00

74LS00	.23	74LS125	.48	74LS260	.58
74LS01	.24	74LS126	.48	74LS266	.54
74LS02	.24	74LS132	.58	74LS273	1.45
74LS03	.24	74LS133	.58	74LS275	3.30
74LS04	.23	74LS136	.38	74LS279	.48
74LS05	.24	74LS137	.98	74LS280	1.95
74LS08	.27	74LS138	.54	74LS283	.68
74LS09	.28	74LS139	.54	74LS290	.88
74LS10	.24	74LS145	1.15	74LS293	.88
74LS11	.34	74LS147	2.45	74LS295	.98
74LS12	.34	74LS148	1.30	74LS298	.88
74LS13	.44	74LS151	.54	74LS299	1.70
74LS14	.58	74LS153	.54	74LS323	3.45
74LS15	.34	74LS154	1.85	74LS324	1.70
74LS20	.24	74LS155	.68	74LS352	1.25
74LS21	.28	74LS156	.68	74LS353	1.25
74LS22	.24	74LS157	.64	74LS363	1.30
74LS26	.28	74LS158	.58	74LS364	1.90
74LS27	.28	74LS160	.68	74LS365	.48
74LS28	.34	74LS161	.64	74LS366	.48
74LS30	.24	74LS162	.68	74LS367	.44
74LS32	.28	74LS163	.64	74LS368	.44
74LS33	.54	74LS164	.68	74LS373	1.35
74LS37	.34	74LS165	.94	74LS374	1.35
74LS38	.34	74LS166	1.90	74LS377	1.35
74LS40	.24	74LS168	1.70	74LS378	1.13
74LS42	.48	74LS169	1.70	74LS378	1.30
74LS47	.74	74LS170	1.45	74LS385	1.85
74LS48	.74	74LS173	.68	74LS386	.44
74LS49	.74	74LS174	.54	74LS390	1.15
74LS51	.24	74LS175	.54	74LS393	1.15
74LS54	.28	74LS181	2.10	74LS395	1.15
74LS55	.28	74LS189	8.90	74LS399	1.45
74LS63	1.20	74LS190	.88	74LS424	2.90
74LS73	.38	74LS191	.88	74LS447	.36
74LS74	.34	74LS192	.78	74LS490	1.90
74LS75	.38	74LS193	.78	74LS624	3.95
74LS76	.38	74LS194	.68	74LS640	2.15
74LS78	.48	74LS195	.68	74LS645	2.15
74LS83	.59	74LS196	.78	74LS668	1.65
74LS85	.68	74LS197	.78	74LS669	1.85
74LS86	.38	74LS221	.88	74LS670	1.45
74LS90	.54	74LS240	.94	74LS674	9.60
74LS91	.88	74LS241	.98	74LS682	3.15
74LS92	.54	74LS242	.98	74LS683	3.15
74LS93	.54	74LS243	.98	74LS684	3.15
74LS95	.74	74LS244	1.25	74LS685	3.15
74LS96	.88	74LS245	1.45	74LS688	2.35
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74LS113	.38	74LS251	.58	81LS96	1.45
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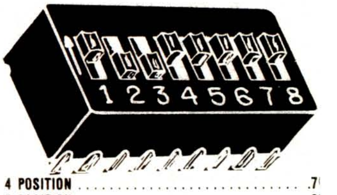
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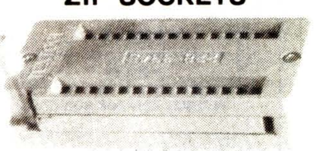
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18 pin ST.	.19	18 pin WW	.9
20 pin ST.	.28	20 pin WW	1.0
22 pin ST.	.29	22 pin WW	1.3
24 pin ST.	.29	24 pin WW	1.4
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2.000	2.0000 MHz	6.9
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8.000	8.0000 MHz	6.9
10.000	10.0000 MHz	6.9
16.000	16.0000 MHz	6.9
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20.000	20.0000 MHz	6.9
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7824T	.74	78L05	.6
7905T	.84	78L12	.6
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7915T	.84	79L12	.7
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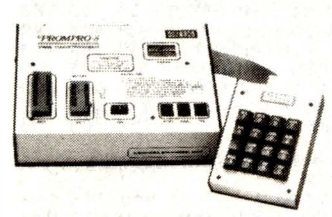
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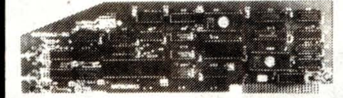
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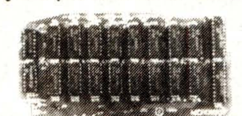
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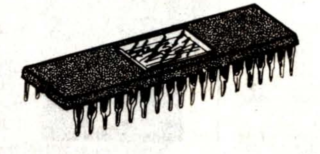
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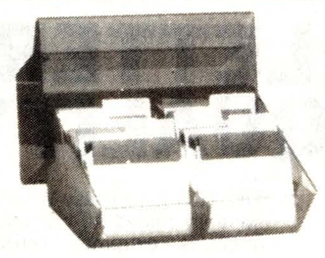


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F10 DAISY WHEEL PRINTER





LETTER QUALITY

The TEC F-10 Daisy Wheel printer is the perfect answer to a reasonablly priced 40 character word processing printer. While this printer is " extremely" similar to C.Itoh's F-10/40 Starwriter printer. Legal counsel for the C.Itoh Company have advised us that we should refrain from referring to the TEC printer as a Starwriter.

This 40 character per second printer auto installs with Wordstar and Perfect Writer. Features extensive built-in word processing functions that allow easy adaptability and reduced software complexity. Industry standard Centronics interface provides instant compatibility with all computers equiped with a parallel printer port. The TEC F-10 accepts paper up to 15 inches in width.

These printers were originally priced to sell at over $1400. Through a special arrangment California Digital has purchase these units from a major computer manufacturer and is offering these printers at a fraction of their original cost.

Options available include tractor feed, buffered memory and an assortment of printer cables for a variety of computers.

UltraLink 1200

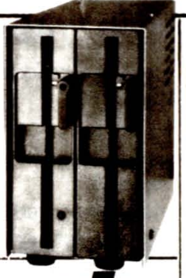


$159

The UltraLink is a Hayes compatible 300/1200 modem designed for the IBM/PC market place. The UltraLink adds a voice/data demension to your PC. Manufacturers original suggested price on this modem is $795. California Digitals price $159.

DUAL SHUGART SUBSYSTEM

$239



The dual Shugart subsystem features two SA465 (96 tpi) 5¼" double sided disk drives. Also supplied within the subsystem is 50 watt power supply and a shielded signal cable.



$99

MEMORY

4164 DYNAMIC MEMORY 150ns



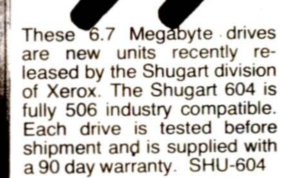
$.99 Quantity 100

DYNAMIC MEMORY

		1-31	32 +	100 +
4164 150ns. 64K 128 refresh	ICM-4164150	1.39	1.19	.99
41256 150ns. 256K	ICM-41256150	6.95	6.50	6.25
4116 150ns. 16K	ICM-4116150	1.75	1.65	1.45
4116 200ns.16K	ICM-4116200	1.75	1.65	1.45
4128 for IBM/AT	ICM-4128150	6.95	6.75	6.35
DP8409 dynamic controller	ICT-8409	39.00	35.00	29.00
STATIC MEMORY				
21L02 200ηs. 1K static	ICM-21L02200	1.49	1.29	1.15
21L02 450ns. 1K static	ICM-21L02450	1.29	1.15	.99
2112 450ns. 2K static	ICM-2112450	2.99	2.85	2.75
2114 300ns. 1K x 4	ICM-2114300	1.95	1.85	1.75
4044TMS 450ns. 4K x 1	ICM-4044450	3.49	3.25	2.99
5257 300ns. 4K x 1	ICM-5257300	2.50	2.25	1.99
6116 P4 200ns. 2K x 8	ICM-6116200	3.95	3.85	3.70
6116 P3 150ns. 2K x 8	ICM-6116150	4.55	4.35	4.15
EPROMS				
2708 450ns. 1K x 8	ICE-2708	4.95	4.75	4.55
2716 450ns. 2K x 8	ICE-2716	4.50	4.25	3.97
2716TMS 450ns. Tri-voltage	ICE-2716TMS	7.95	7.65	7.25
2732 450ns. 4K x 8	ICE-2732	4.50	3.75	3.55
2764 350ns. 8K x 8	ICE-2764	5.95	5.75	6.25
27128 350ns. 16K x 8	ICE-27128	7.95	7.35	6.95

Shugart 604 WINCHESTER

$99



These 6.7 Megabyte drives are new units recently released by the Shugart division of Xerox. The Shugart 604 is fully 506 industry compatible. Each drive is tested before shipment and is supplied with a 90 day warranty. SHU-604

Five Inch Winchester Hard Disk Drives			
FUJITSU M2235AS	27 Meg.	899	859
RODIME RO-208	53 Meg.	1589	1493
MAXTOR XT10140	140 Meg.	3895	3785
SHUGART 712	13 Meg. ½ Ht	495	465
SHUGART 604	6.7 Meg.	99	89
TANDON 502	10 Meg.	419	395
TANDON 503	19 Meg.	695	675
SEAGATE 225	25 Meg.	695	625

TEAC 55B 48 TPI

	One	Two	Ten
Five Inch Double Sided Drives			
TEAC FD55B half height	99	95	89
TEAC FD55F 96 TPI, half ht.	119	115	109
CONTROL DATA 9409 PC	169	159	155
SHUGART SA455 Half Height	99	95	89
SHUGART SA465 ½ Ht. 96TPI	99	95	89
TANDON 100-2 full height	129	125	119
TANDON 101-4 96TPI full ht.	199	189	179
MITSUBISHI 4851 half height	139	135	129
MITSUBISHI 4853 96/TPI½ Ht.	155	149	139
MITSUBISHI 4854 8" elec.	295	285	275
QUME 142 half height	119	105	99
Eight Inch Single Sided Drives			
SHUGART 801R			
SIEMENS FDD 100-8	119	115	109
TANDON 848E-1 Half Height	369	359	349
Eight Inch Double Sided Drives			
SHUGART SA851R	495	485	475
QUME 842 "QUME TRACK 8"	319	319	313
TANDON 848E-2 Half Height	459	447	435
REMEX RFD-4000	219	219	209
MITSUBISHI M2896-63 ½ Ht.	459	449	409



Shipping: First five pounds $3.00, each additional pound $.50.
Foreign orders: 10% shipping, excess will be refunded.
California residents add 6½% sales tax. ● COD's discouraged.
Open accounts extended to state supported educational institutions and companies with a strong "Dun & Bradstreet" rating.



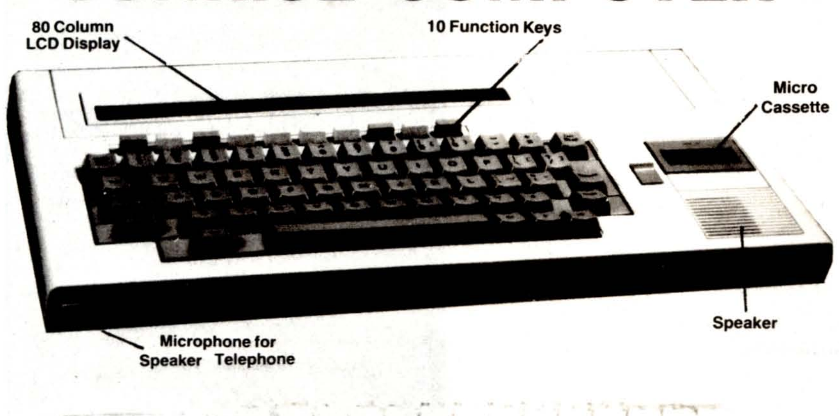
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XEROX $299

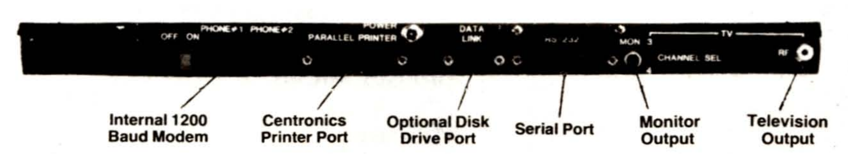
SUNRISE COMPUTER

~~$2995~~



Optional Printer





The Xerox Sunrise 1810 is by far the best value we have ever seen in a micro computer. This is a self contained battery and AC operated portable. The Sunrise was originally priced at $2995. Xerox has since elected to drop the computer from their product list. California Digital has purchased all the remaining inventory and is making the unit available at a fraction of its original cost.

This portable features a built in 80 column liquid crystal display, along with both RF monitor and television outputs. The internal 300/1200 baud modem includes an auto dial telephone assembly. The units has both centronics parallel and a serial port programmable to 19,200 baud.

The self contained micro cassette is capable of capturing data from the keyboard as well as doubling as an recorder for dictating messages.

An optional dual floppy disk drive module, pictured above, is available for only $219. (when purchased with the Sunrise 1810). Also available, for $59 is an 80 column printer that mounts in the drive module. The Sunrise features a CP/M operating system which allows the operator to use any CP/M program in Xerox 5¼" disk format and over 5000 CP/M programs available in public domain.

PRINTERS

MATRIX PRINTERS

Star Gemini-SG10 120 char/sec	STR-SG10	239.00
Star Gemini-SG15, 100 char/sec 15" paper	STR-SG15	389.00
Star Gemini Delta 10, 160 Char/sec	STR-D10	359.00
Citizen MSP/10FT 160 char/sec	CIT-MSP10	289.00
Toshiba P1351, 192 char/sec letter quality	TOS-1351	1495.00
Okidata 182A serial & parallel 9½" paper	OKI-182A	257.00
Okidata 192A parallel interface, 160 char/sec	OKI-192A	345.00
Okidata 84P parallel 15" paper	OKI-84P	789.00
Epson LX-80 10" 120 Char/sec	EPS-LX80	239.00
Epson FX80FT, 10" 160 char/sec with graphtrax	EPS-FX80	369.00
Epson RX100 15" withGraphtrax	EPS-RX100	389.00
Epson FX100FT 15" 160 char/sec with graphtrax	EPS-FX100	489.00
Epson LQ1500, 15" correspondence quality	EPS-LQ1500	895.00
Epson JX80 Color printer	EPS-JX80	519.00
Prowriter 8510 parallel 9½" paper	PRO-8510P	329.00
Dataproducts B-600-3, band printer 600 LPM	DPS-B600	6985.00
Printronix P300 high speed printer 300 lines per minute	PTX-P300	3995.00
Printronix P600 ultra high speed 600 lines per minute	PTX-P600	5795.00

WORD PROCESSING PRINTERS

Starwriter F10 parallel, 40 char/sec	PRO-F10P	499.00
NEC8810 55 char second, serial interface	NEC-8810	1659.00
NEC8830 55 char/sec par'l interface	NEC-8830	1659.00
NEC3550 popular printer designed for the IBM/PC	NEC-3550	1599.00
NEC2050 designed for IBM/PC 20 char/sec par'l	NEC-2050	689.00
Silver Reed EXP500, 14 char/sec par'l interface	SRD-EXP500	319.00
Silver Reed EXP550 17 Char/sec par'l interface	SRD-EXP550	429.00
Diablo 630 40 char/sec serial	DBL-630	1569.00
Diablo 620, proportional spacing, horz & vert tab, 20 cps	DBL-620	769.00
Juki 6100, 18 char/sec	JUK-6100	399.00
Juki 6300, 40 char/sec	JUK-6300	699.00
Comrex CR2, 5k buffer, proportional spacing, par'l	CRX-CR2P	395.00

TERMINALS

Freedom 100 split screen, detatchable keyboard	LIB-F100	495.00
Qume 102 green phosphor terminal	QUM-102	539.00
Ampex Dialogue 125 green screen	APX-D125G	675.00
Ampex Dialouge 175 amber screen, two page, func. keys	APX-D175A	719.00
Wyse 50, 14" green phosphor	WYS-50	495.00
Wyse 300, Eight color display, split screen	WYS-300	1159.00
Zenith 29 terminal, VT52 compatible, detatchable keyboard	ZTH-Z29	765.00
Televideo 910 Plus, block mode	TVI-910P	575.00
Televideo 925, detatchable keyboard, 22 function keys	TVI-925	759.00
Televideo 950, graphic char, split screen, 22 func	TVI-950	950.00
Televideo 970, 14" green, 132 column, European	TVI-970	1095.00

1200 BAUD

UNIVERSAL DATA

$119

The UDS-212LP is a compact desktop modem designed to obtain all its operating power entirely from the telephone line thus eliminating the need to connect to an external AC power source. NOT Hayes compatible but the ideal 1200 baud modem to connect to any CRT terminal or computer when accessing dial up data bases.

The Universal Data Division of Motorla original suggested list price on the 212/LP was $ 495. but California Digital is offering at only $119.

SMARTEAM 1200 $189

The Team 212A offers all the features of the Hayes Smart Modem 1200 for a fraction of the price. Now is your opportunity to purchase a 1200 baud modem at the price of a 300 baud modem.

MODEMS

Hayes Smartmodem 2400 baud modem	HYS-2400	599.00
Fujitsu 2400/1200 baud auto everything	FUJ-1935D	439.00
Team 1200 Hayes Compatible	TEM-SM1200	189.00
UltraLink 1200 data and voice on same line	UTL-1200A	159.00
CTS 212AH 1200 baud, auto dial	CTS-212AH	259.00
Terminal software for CTS 212AH	CTS-212SFT	35.00
Prometheus 1200 super features	PRM-P1200	319.00
Prometheus 1200B internal PC	PRM-P1200B	279.00
Signalman Mark 12, 1200 baud, Hayes compatible	SGL-MK12	239.00
Signalman Mark VI, 300 baud internal PC	SGL-MK6	59.00
Hayes Smart Modem 1200 baud, auto answer, auto dial	HYS-212AD	429.00
Hayes 1200B for use with the IBM/PC, 1200 baud	HYS-1200B	399.00
Hayes Smartmodem, 300 baud only, auto answer, auto dial	HYS-103AD	229.00
Hayes Micromodem II, 103 Apple direct connect	HYS-MM2	279.00
Hayes Chronograph, time & date	HYS-CHR232	199.00
Penril 300/1200 industrial quality	PEN-12AD	395.00
Universal Data 103JLP, line power, auto answer	UDS-103LP	39.00
Universal Data 212LP, full 1200 baud duplex, line power	UDS-212LP	119.00
Universal Data 212A, 1200 baud, industrial Line	UDS-212A	179.00

PLOTTER

$219

The Comrex Comscriber I is the ideal solution to make short work of translating financial and numeric data into a graphic presentation. Many ready to run programs such as Lotus 1-2-3, Visi-on and Apple business graphics already support this plotter.

The Comscriber I features programmable paper sizes up to 8½ by 120 inches, 6 inch per second plot speed and 0.004" step size. Easy to implement Centronics interface allows the Comscriber I immediate use with the printer port of most personal computers.

The Comscriber I is manufactured for Comrex by the Enter Computer Corporation. The plotter is marketed by Heath Kit and also sold under Enters own "Sweet P" Label. This is your opportunity to purchase a plotter which was originally priced at $795 for only $219.

Also available is a support package which includes demonstration software, interface cable, a multicolor pen assortment and a variety of paper and transparency material.



NEC RGB COLOR MONITOR

$219

The NEC JC-1401D is a 13" medium/high resolution RGB monitor suitable for use with the Sanyo MBC-550/555 or the IBM/PC. The monitor features a resolution of 400 dots by 240 lines. Colors available are Red, Green, Blue, Yellow, Cyan, Magenta, Black and White.

The NEC monitor carries the Litton-Monroe label and was originally scheduled for use in their "Office of the Future" equipment. A change in Monroe's marketing strategy has made these units excess inventory which were sold to California Digital. We are offering these "new" RGB monitors at a fraction of their original cost. Sanyo compatible NEC-1401/S; IBM/P/C Computer compatible NEC-1401/PC

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Apple IIc w/Monitor & Stand	1059

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ML182 IBM Graphics Comp	219
ML182S 10" Carriage	265
ML192P, 160 cps	359
ML192 IBM Graphics Comp	359
ML192S, 160 cps	419
ML193P, 160 cps	499
ML193 IBM Graphics Comp	499
ML193S, 160 cps	569
ML84P, 200 cps	655
ML84 IBM	655
ML84S, 200 cps	775
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JX80	Call
RX100	Call
FX185	Call
LQ1500	Call
SQ2000	Call

QUME

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Sprint 1140 +, 2K, 40 cps, 132 col. width	1229

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SG15Ft, 120 cps, corr. qual.	389
SD10Ft, 160 cps, corr. qual.	359
SD15Ft, 160 cps, corr. qual.	475
SR10Ft, 200 cps, corr. qual.	499
SR15Ft, 200 cps, corr. qual.	629
SB10 Draft, 144 cps, NLQ 60 cps	795
Powertype, 18 cps Bi-Di	359

C. ITOH

7500 AP, Parallel	$ 219
7500 EP, IBM Compatible	219
7500 AR, Serial	265
8510 AP, Parallel	299
8510 AP + NLQ Mode	319
8510 BPI, IBM Compatible	319
1550 P, Parallel	440
1550 BP + NLQ Mode	460
1550 EP, IBM Compatible	440
1550 BCD, Serial	499

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JUKI

6100, L.Q. 18 cps w/proportional spc.	$ 369
6300, 40 cps	689

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P351 P, Faster than 1351	1229
P351 P/S, Faster & more versatile	1250

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1093, 15" car. 160 cps	669

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- 128K
- 1 Dbl/Dbl Disk Drive
- Taxan Amber #116

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"THE COMPANY

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Grappler +	$ 85
Buffered Grappler +, 16K exp. 64K	150

TOSHIBA

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Font Disk for Down loading P1351	50

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Additional Buffering 16K	12

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OKIDATA

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Okigraph I for 82A	49
Okigraph I for 83A	49
Tractor for 182	39

JUKI

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Serial Interface	65

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Tractor for HR35	129
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Cut Sheet Feeder for HR25/35	199
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- Color Card
- Taxan.Amber #116

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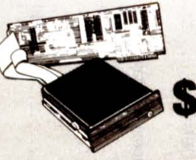
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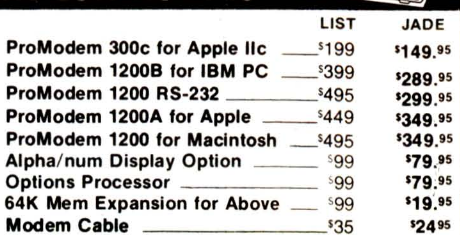
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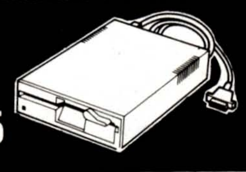
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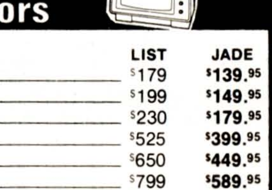
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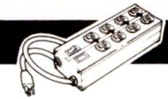
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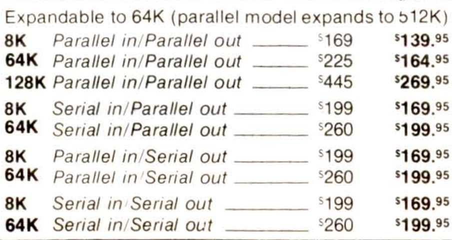
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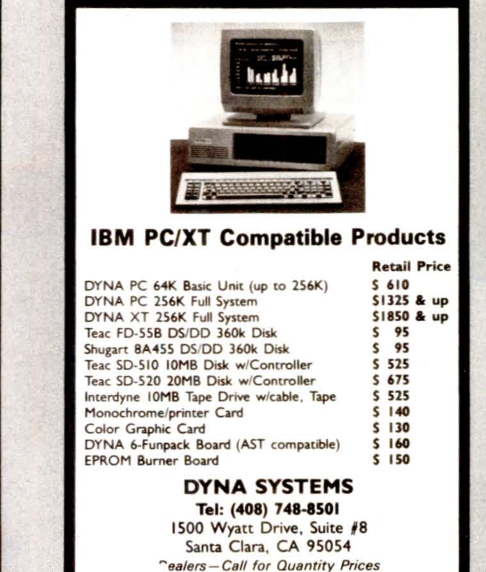
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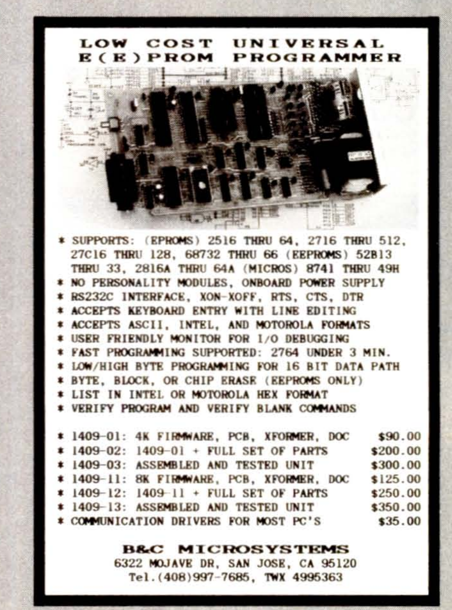
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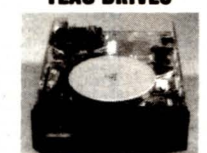
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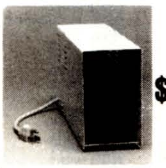


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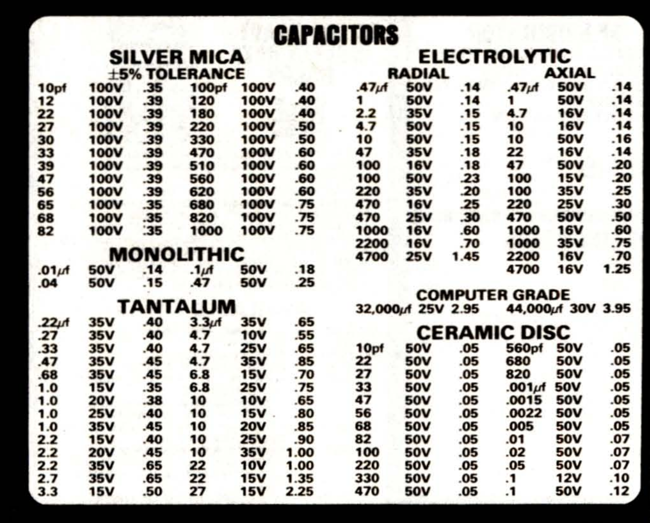
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39	100V	.39	510	100V	.60
47	100V	.39	560	100V	.60
56	100V	.39	620	100V	.60
65	100V	.35	680	100V	.75
68	100V	.35	820	100V	.75
82	100V	.35	1000	100V	.75

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.04	50V	.15	.47	50V	.25

TANTALUM

.22µf	35V	.40	3.3µf	35V	.65
.27	35V	.40	4.7	10V	.55
.33	35V	.40	4.7	25V	.65
.47	35V	.45	4.7	35V	.85
.68	35V	.45	6.8	15V	.70
1.0	15V	.35	6.8	25V	.75
1.0	20V	.38	10	10V	.65
1.0	25V	.40	10	15V	.80
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2.2	15V	.40	10	25V	.90
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2.7	35V	.65	22	15V	1.35
3.3	15V	.50	27	15V	2.25

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.47µf	50V	.14	.47µf	50V	.14
1	50V	.14	1	50V	.14
2.2	35V	.15	4.7	16V	.14
4.7	50V	.15	10	16V	.14
10	50V	.15	10	50V	.16
47	35V	.18	22	16V	.14
100	16V	.18	47	50V	.20
100	50V	.23	100	15V	.20
220	35V	.20	100	35V	.25
470	16V	.25	220	25V	.30
470	25V	.30	470	50V	.50
1000	16V	.60	1000	16V	.60
2200	16V	.70	1000	35V	.75
4700	25V	1.45	2200	16V	.70
			4700	16V	1.25

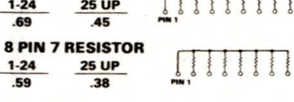
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22	50V	.05	680	50V	.05
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33	50V	.05	.001µf	50V	.05
47	50V	.05	.0015	50V	.05
56	50V	.05	.0022	50V	.05
68	50V	.05	.005	50V	.05
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RESISTOR NETWORKS

SIPs



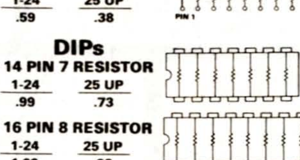
10 PIN 9 RESISTOR

1-24	25 UP
.69	.45

8 PIN 7 RESISTOR

1-24	25 UP
.59	.38

DIPs

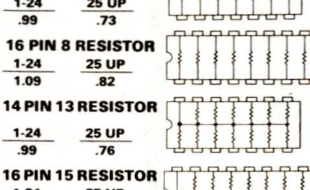


14 PIN 7 RESISTOR

1-24	25 UP
.99	.73

16 PIN 8 RESISTOR

1-24	25 UP
1.09	.82



14 PIN 13 RESISTOR

1-24	25 UP
.99	.76

16 PIN 15 RESISTOR

1-24	25 UP
1.09	.85

AVAILABLE VALUES: 100, 220, 330, 470, 680, 1K, 2.2K, 3.3K, 4.7K, 6.8K, 10K, 22K, 33K, 47K, 100K

16 PIN 14 LINE TERMINATOR
AVAILABLE IN ONLY
180/390, 220/270, 220/330

1-24	25 UP
1.49	1.05

TRIMMER POTENTIOMETERS

SINGLE TURNS 72PRxx

1-24	25 UP
.99	.85

15 TURN 89PRxx

1-24	25 UP
1.49	1.28

SINGLE TURN 91ARxx

1-24	25 UP
.99	.88

AVAILABLE VALUES: 100, 500, 1K, 5K, 10K, 20K, 50K, 100K, 1 MEG.

ORDERING INSTRUCTIONS: INSERT RESISTANCE VALUE IN PLACE OF "xx".

EXAMPLE: A 500 OHM 89 SERIES POTENTIOMETER WOULD BE 89PR500.

THUMBWHEEL POTS

THUMBxx

1-24	25 UP
.49	.45

AVAILABLE VALUES: 1K, 2.5K, 5K, 10K, 25K, 50K, 100K, 250K, 500K

ORDERING INSTRUCTIONS: SEE TRIMMER POTENTIOMETERS ABOVE

PAGE WIRE WRAP WIRE

PRECUT AND STRIPPED

Note: 1 inch of insulation is stripped on each end. 3.5" wire has only 1.5 inchs of insulation.

LENGTH (INCHES)	QUANTITY 100	500
2.5	1.60	4.70
3.0	1.60	4.70
3.5	1.65	5.00
4.0	1.75	5.40
4.5	1.80	5.75
5.0	1.85	6.10
5.5	1.90	6.50
6.0	2.00	6.85
6.5	2.30	7.80
7.0	2.40	8.20
8.0	2.60	8.95
9.0	2.70	9.80
10.0	2.90	10.50

PRECUT ASSORTMENT
IN ASSORTED COLORS $27.50

100ea: 5.5", 6.0", 6.5", 7.0"
250ea: 2.5", 4.5", 5.0"
500ea: 3.0", 3.5", 4.0"

SPOOLS

100 feet	$4.30	250 feet	$7.25
500 feet	$13.25	1000 feet	$21.95

Please specify color: Blue, Black, Yellow or Red

RESISTORS

¼ WATT 5% CARBON FILM
ALL STANDARD VALUES
FROM 1 OHM TO 10 MEG. OHM

10 PIECES SAME VALUE	.05
50 PIECES SAME VALUE	.025
100 PIECES SAME VALUE	.02
1000 PIECES SAME VALUE	.015

IC EXTRACTION TOOL

ONE PIECE METAL CONSTRUCTION
EXTRACTS 8-24 PIN DEVICES

$1.49

MUFFIN FANS

MADE BY	JDR #	SIZE	CFM	VOLTS	PRICE
MASUSHITA	MUFFIN-DC	3.18"sq x 1.25"	16	12 VDC	$16.95
ROTRON	MUFFIN-ROTRON	3.15"sq x 1.66"	34	115 AC	$14.95
ETRI	MUFFIN-3	3.63"sq x 1.00"	32	115 AC	$12.95
ETRI	MUFFIN-4	4.70"sq x 1.52"	55	115 AC	$14.95
TORIN	MUFFIN-230	4.70"sq x 1.50"	60	230 AC	$4.95

TWO LEVEL WIRE WRAP SOCKETS

THESE SOCKETS HAVE .50" LEADS, JUST A LITTLE BIT SHORTER THAN THE 3 LEVEL WIRE WRAP SOCKETS WITH .6" LEADS

	1-99	100-UP
8 PIN WW-2	.40	.35
14 PIN WW-2	.45	.39
16 PIN WW-2	.45	.39
20 PIN WW-2	.75	.59
22 PIN WW-2	.50	.39
24 PIN WW-2	.69	.75
28 PIN WW-2	.89	.75

OK INDUSTRIES

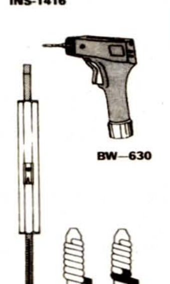
EX-2 IC EXTRACTION TOOL
- EXTRACTS 24-40 PIN DEVICES
- HEAVY DUTY METAL CONSTRUCTION
- GROUND LUGS FOR MOS EXTRACTIONS
- EASY ONE HAND OPERATION $12.74

IC INSERTION TOOLS

INS-1416	for 14-16 pin IC's	$5.15
MOS-1416	for 14-16 pin IC's	$10.92
MOS-2428	for 24-28 pin IC's	$10.92
MOS-40	for 40 pin IC's	$12.43

MOS series insertion tools have metal constuction and include grounding lug for CMOS applications.

INS-1416 INS-2428



BW—630

BW-630 WIRE WRAP GUN
- BATTERY POWERED-USES 2 NI-CAD C CELLS(NOT INCLUDED)
- POSITIVE INDEXING
- ANTI-OVERWRAP DEVICE $41.55

WSU-30 WIRE WRAP TOOLS
- WRAPS, STRIPS, AND UNWRAPS
- WSU-30M WRAPS AN EXTRA TURN OF INSULATION

WSU-30 $8.84/WSU-30M $10.14

WSU-30/30M

WIRE WRAP TERMINALS

WWT-1	SLOTTED	25/$7.06
WWT-2	SINGLE SIDED	25/$4.25
WWT-3	IC SOCKET	25/$7.06
WWT-4	DOUBLE SIDED	25/2.80
INS-1	INSERTION TOOL	$3.64

WIRE DISPENSER



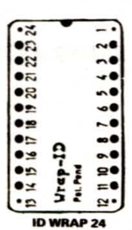
- WITH 50' ROLL OF WIRE
- BUILT IN PLUNGER CUTS WIRE
- BUILT IN STRIPPER STRIPES 1"
- REFILLABLE

WD-30 $6.50 — Specify Blue, white, Yellow or Red
WD-30TRI $9.50 — With 50' of each: Red, Blue and White

SOCKET-WRAP I.D.™
- SLIPS OVER WIRE WRAP PINS
- IDENTIFIES PIN NUMBERS ON WRAP SIDE OF BOARD
- CAN WRITE ON PLASTIC; SUCH AS IC #

PINS	PART#	PCK. OF	PRICE
8	IDWRAP 08	10	1.95
14	IDWRAP 14	10	1.95
16	IDWRAP 16	10	1.95
18	IDWRAP 18	5	1.95
20	IDWRAP 20	5	1.95
22	IDWRAP 22	5	1.95
24	IDWRAP 24	5	1.95
28	IDWRAP 28	5	1.95
40	IDWRAP 40	5	1.95

PLEASE ORDER BY NUMBER OF PACKAGES (PCK. OF)



ID WRAP 24

WIRE WRAP PROTOTYPE CARDS

FR-4 EPOXY GLASS LAMINATE
WITH GOLD-PLATED EDGE-CARD FINGERS

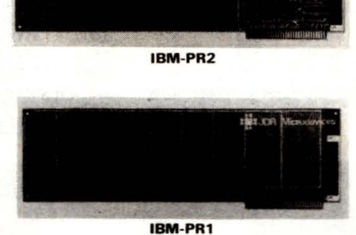
IBM
BOTH CARDS HAVE SILK SCREENED LEGENDS AND INCLUDES MOUNTING BPACKET

IBM-PR1	WITH +5V AND GROUND PLANE	$27.95
IBM-PR2	AS ABOVE WITH DECODING LAYOUT	$29.95

IBM-PR2

S-100

P100-1	BARE - NO FOIL PADS	$15.15
P100-2	HORIZONTAL BUS	$21.80
P100-3	VERTICAL BUS	$21.80
P100-4	SINGLE FOIL PADS PER HOLE	$22.75



IBM-PR1

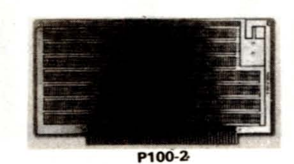
APPLE

P500-1	BARE - NO FOIL PADS	$15.15
P500-3	HORIZONTAL BUS	$22.75
P500-4	SINGLE FOIL PADS PER HOLE	$21.80
7060-45	FOR APPLE IIe AUX SLOT	$30.00

GENERAL PURPOSE

22/44 PIN EDGE-CARD (.156" SPACING)

P441-1	4.5" x 6.0" BARE - NO FOIL PADS	$9.45
P441-3	4.5" x 6.0" VERTICAL BUS	$13.95
P441-4	4.5" x 6.0" SINGLE FOIL PADS	$14.20
P442-1	4.5" x 9.0" BARE - NO FOIL PADS	$10.40
P442-3	4.5" x 9.0" VERTICAL BUS	$14.20
P442-4	4.5" x 9.0" SINGLE FOIL PADS	$13.50



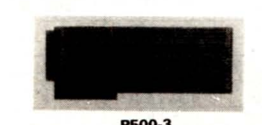
P100-2

36/72 PIN EDGE-CARD (.1" SPACING)

P721-1	4.5" x 6.0" BARE - NO FOIL PADS	$9.45
P721-3	4.5" x 6.0" VERTICAL BUS	$13.25
P721-4	4.5" x 6.0" SINGLE FOIL PADS	$14.20
P722-1	4.5" x 9.0" BARE - NO FOIL PADS	$10.40
P722-3	4.5" x 9.0" VERTICAL BUS	$14.20
P722-4	4.5" x 9.0" SINGLE FOIL PADS	$15.15

NO EDGE-CARD FINGERS

P25x45	2.5" x 4.5" BARE - NO FOIL PADS	$2.40
P45x65	4.5" x 6.5" BARE - NO FOIL PADS	$4.70
P45x85	4.5" x 8.5" BARE - NO FOIL PADS	$6.20
P45x17	4.5" x 17.0" BARE - NO FOIL PADS	$11.35
P85x170	8.5" x 17.0" BARE - NO FOIL PADS	$18.95



P500-3

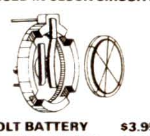
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5 VDC	SPST REED	DIP	3.95
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6 VDC	6PDT 3 AMP	RELAY SOC	2.95
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MC-Z80	Z80 MPU
MC-6502	6502 (65xx)MPUs
MC-8085	8080A AND 8085A MPUs
MC-8048	8048 SINGLE CHIP MPU FAMILY
MC-CL	"C" LANGUAGE- COMPREHENSIVE REFERENCE FOR PROS AND BEGINNERS
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MC-7400	PINOUTS AND FUNCTIONS OF VIRTUALLY ALL 54/7400 TTL IN NEW COMPACT TABLE FORMAT (REG. H. L. LS. S)
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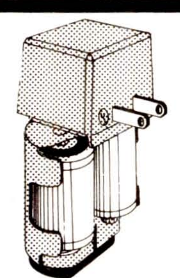
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PRICE INCLUDES CHARGER (WALL PLUG), BATTERIES, & MODULAR BATTERY HOLDER

AAA CELLS	QTY. 2	$11.71
AA CELLS	QTY. 2	$11.71
C CELLS	QTY. 2	$13.21
D CELLS	QTY. 2	$13.21
9 VOLT	QTY. 1	$13.21

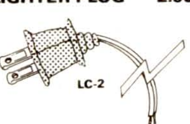
BATTERIES ONLY

AAA CELLS	PKG. 2	$6.07 pr.
AA CELLS	PKG. 1	$3.03 ea.
C CELLS	PKG. 1	$3.78 ea.
D CELLS	PKG. 1	$3.78 ea.
9 VOLT	PKG. 1	$7.57 ea.



SIX FOOT LINE CORDS

LC-2	2 CONDUCTOR	.39
LC-3	3 CONDUCTOR	.99
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* FOR IBM PC-XT COMPATIBLE
* 130 WATTS
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* ONE YEAR WARRANTY



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* FOR IBM PC-XT COMPATIBLE
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* -12 @ .5A, -5 @ .5A
* ONE YEAR WARRANTY



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* 100 WATTS
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* 90 DAY WARRANTY

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* UL APPROVED



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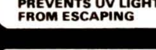
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* LOW COST
* COMPACT - NO DRAWER
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EPROM ERASERS



Model	Timer	Capacity Chip	Intensity (uW/Cm²)	Unit Price
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PE-14T	YES	9	8,000	$119.00
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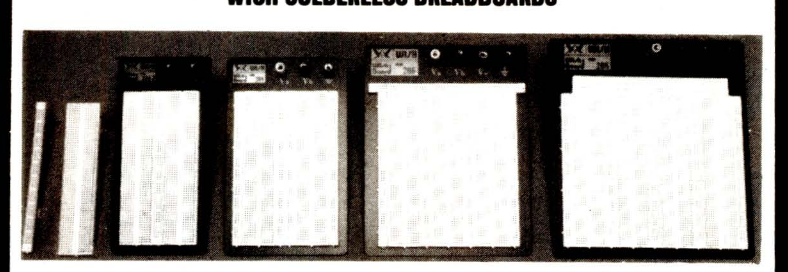
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WBU-D	.38 x 6.50"	1	100	---	---	---	2.95
WBU-T	1.38 x 6.50"	---	---	1	630	---	6.95
WBU-204-3	3.94 x 8.45"	1	100	2	1260	2	17.95
WBU-204	5.13 x 8.45"	4	400	2	1260	3	24.95
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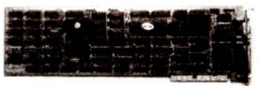
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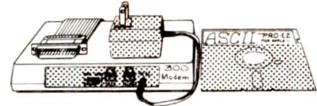
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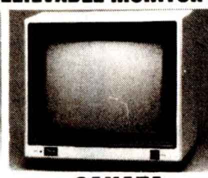
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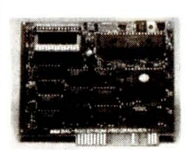
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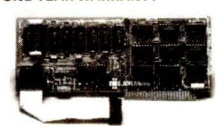
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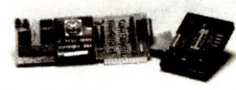
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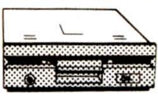
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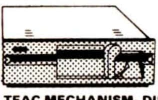
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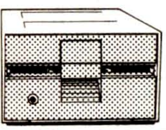
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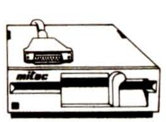
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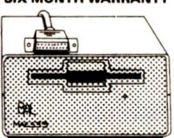
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WANTED: Nonprofit educational institution seeks tax-deductible contribution of a disk-based microcomputer with printer (Apple, IBM, or TRS-80 preferred) for classroom use with handicapped students. Risa K. Allen, Midway Elementary School, Milledgeville, GA 31061, (912) 452-2413.

WANTED: Nonprofit school for disadvantaged adults seeks tax-deductible donation of personal computers or stand-alone machines. Dr. Dodd, Omaha Opportunities Industrialization Center, 2724 North 24th St., Omaha, NE 68110, (402) 457-4222.

WANTED: Catholic Social Services needs tax-deductible donation of IBM PC or equivalent with printer for spreadsheet, database word processing, and mailing list to use in family-focused adolescent sexuality program. Gail Zettel, Catholic Social Services, Wayne County, 9851 Hamilton Ave., Detroit, MI 48202, (313) 883-2100.

WANTED: Tax-deductible contribution of operational word processor. Rev. Virginia Jones, Ashburnham Community Church, Ashburnham, MA 01430, (617) 827-5553.

WANTED: Hard-disk microcomputer, preferably a Vector Graphic, for a 501 (c) (3) nonprofit public policy research and education organization. Tax-deductible. APJ Education Fund, Suite 218, 806 15th St. NW, Washington, DC 20005.

NEEDED: Nonprofit educational group devoted to Western mysticism and new science needs word-processing equipment (two or more terminals with printers). IBM PC-compatible or CP/M. Tax-deductible. Contact Jim Holland, Friends of Creation Spirituality, POB 19216, Oakland, CA 94619.

WANTED: Computer engineering student would like to exchange public-domain programs and information for the NCR Decision Mate V computer. Juan Fdo. Toro G., Apartado Aéreo 52020, Medellín, Colombia, South America.

WANTED: High-technology student needs Apple II or II+ public-domain software for education. Will send in return programs from my public-domain library. Would also like to buy a used graphic light-pen system. Joakim Lindberg, Hökvägen 20, 93143 Skellefteå, Sweden.

WANTED: Computer enthusiasts worldwide to exchange views and ideas. I am an Apple II user. Oscar Lau, P.O. Box 1133, Sibu, Sarawak, Malaysia.

FOR SALE: MPX-16 microcomputer. IBM-compatible. Power supply, case, Micromint ST-1000 smart terminal board, 128K, support ROMs for terminal or IBM-type keyboard and keyboard adapter, two Tandon SS/DD disk drives in separate case with power supply, and more. $1400. Richard Bryant, 1631 Kings Dr. #411, Bartlesville, OK 74006, (918) 335-0888.

FOR SALE: Auto-dial/auto-answer, direct-connect 300-bps modem for Apple. Bare PC board with EPROM and TMS99532: $50. Tab and Heath books, assorted electronic components: will sell or trade for back issues of BYTE, pre-1981 *Radio-Electronics*, or Apple books, magazines, or hardware. Send list. Michael Schwarz, POB 146, Danville, WA 99121.

FOR SALE: TRS-80 Model 100 with 32K RAM, DC power supply, cassette (CCR-82) with cable and DC power supply, direct-connect modem cable, cigarette lighter DC adapter, and two cassette pallets. Books, manuals, and more. $600 or best offer. Kenneth Humbard, POB 4-972, Anchorage, AK 99509, (907) 563-4376.

FOR SALE: Osborne 1 computer with tan case and SS/DD drives. Excellent condition, recently underwent preventive maintenance. $500. Jeremy Kezer, (203) 535-2623.

WANTED: Persons wishing to correspond with individual just learning BASIC on a Timex Sinclair 1000. Interested in exchanging information on practical usages, new modes, and "living symbols." S. Steps, c/o POB 163777, Sacramento, CA 95816.

FOR SALE: Early BYTE issues, from number 1 to 1980. Also early issues of *Kilobaud* and *80 MicroComputing*. Greg Ludwig, 910 Soo Blvd., Rice Lake, WI 54868, (715) 234-2680.

FOR SALE: Alphacom printer, datasette, TV/monitor for Commodore 64-compatible, and public-domain software: $470. New; good condition. Wish to buy Commodore 64 disk drive and monitor in good condition. Nicole Taroin, 52-06 Skillman Ave. 2R, Woodside, New York, NY 11377, (718) 507-2484.

FOR SALE: Intel SBC/Multibus System: SBC 80/20-4 board with 8080A CPU, clock, 4K RAM, 8K ROM, 48 I/O lines, RS-232C drivers and receivers; SBC 016A 16K RAM expander board; SBC 204 disk controller; Vector plugboard; mounted in Intel 4-slot card cage, manuals: $850 plus shipping. Rich Myers, 3211 Standish, Cleveland, OH 44134, (216) 845-1015.

FOR SALE: Ohio Scientific C8P computer system. Includes 48K RAM, dual 8-inch disk drives, Epson MX-80 printer with serial interface card and ribbons, RF (TV) converter, 12-inch black-and-white TV, all cables, manuals, and more. We will pay to ship in original cartons. Asking $2000. Brad Chase or Tim Jones, POB 321, Epping, NH 03042, (603) 679-2404.

WANTED: Information, manuscripts, and reprints of articles dealing with software copyright protection, software law, and software piracy. D. C. Eshbaugh, Department of Anthropology, Arizona State University, Tempe, AZ 85287.

FOR SALE: Cromemco Z-2D 64K with dual 5-inch floppies. Spare 16K board and many other extras. No reasonable offer refused. Steve Robinson, Precept Ministries, POB 23000, Chattanooga, TN 37422, (615) 892-6814.

FOR SALE: First three and a half volumes (missing volume 3, number 3) of *S-100 Microsystems* magazine. First offer over $60. C. Hill, Apt. #312, 27904 Pacific Highway S, Federal Way, WA 98003.

FOR SALE: S-100 Sol-20 computer: $500. 64K static memory board: $150. Morrow controller: $150. 8-inch SS/DD enclosed drives: each $350. Sanyo 9-inch black-and-white monitor: $75. Anderson Jacobson 841 Selectric with parallel interface: $400. BYTE, 1978 through 1983: $125. John Ross, 327 Chestnut St., Batavia, IL 60510, (312) 879-2583.

WANTED: Broken Apple IIs, II+s, or IIes and broken peripheral devices (cards, drives, etc.). Good price; I will pay shipping. Gary Raabe, 4729 Broughton, Corpus Christi, TX 78415.

FOR SALE: Video-display terminal, Model ADM 1A, full keyboard with numeric pad, special function keys, block and line transmit functions. Excellent condition. $250. T. Kruckewitt, 7749 College Town Dr. #130, Sacramento, CA 95826, (916) 383-0782.

FOR SALE: Used 192K-byte memory-expansion module for DEC Rainbow 100A (PC1XX-AB): $200. Henry Suzukawa, 22266 Schoenborn, Canoga Park, CA 91304.

FOR SALE: IBM PC Portable with 256K, two DD/DS disk drives, serial port, and more. Excellent condition: $2700. Joe Decker, 93-95 Lake St., Rouses Point, NY 12979, (518) 297-7933.

FOR SALE: Big Board II with two Shugart SS/DD 600K drives, 15-inch monitor, and keyboard: $850; two MPI DS/DD 360K disk drives in a Heath Z-37 case and power supply: $250; Centronics One parallel printer, Silver Paper: $50. John Wytsma, 9 Pitch Pine Dr., Topsham, ME 04086, (207) 725-4209.

FOR SALE: Commodore 64 system. Includes 1541 disk drive, 1701 color monitor, 1525 dot-matrix printer, KoalaPad graphics tablet, 80-column card, other add-ons, joysticks, etc. Light use; $900 or best offer. Michael Feldman, 615 Finch Ave. W, Toronto, Ontario M2R 1N8, Canada, (416) 633-1750.

FOR SALE: Motorola 68000 VERSAmodule computer system with 512K-byte RAM, universal I/O, universal disk controller, 16-megabyte hard disk, card cage, and power supplies: $3000. Hugh Shane, 7 Green Meadow Rd., Pleasantville, NY 10570.

FOR SALE: Hewlett-Packard 87XM computer, 82905B printer, 82936A ROM drawer, 00087-15002 plotter ROM, 00087-15012 electronic disk ROM, and more. Perfect condition. J. A. Henebry, (518) 371-0423.

WANTED: June and September 1981 BYTE. First response gets $6 check for each; you forward prepaid. Ed Niebuhr, 15 Springhill Lane, Lafayette, CA 94549, (415) 283-2644.

WANTED: Motorola MEX 68KECB 68000 education board. Don Lewis, 606 Hazel Ave., Folsom, PA 19033, (215) 586-5212.

FOR SALE: S-100 cards. IMSAI MPU-A: $35. MPU-B: $200. PIC-8: $35. Processor Technology 8K static RAM: $20. CUTS cassette interface: $20. As is. John Lin, 5501 South Kenwood, Chicago, IL 60637, (312) 684-3689, evenings.

WANTED: Spectravideo 328 user seeks correspondence with other SV users. R. A. Fortune, 46 West 17th St., New York, NY 10011.

WANTED: Schematic/documentation on Vector Graphic Flashwriter IV card and Micropolis PCB transmitter and bus receiver cards. Will reimburse costs. G. Carroll, 4915 Berryman Ave., Culver City, CA 90230, (213) 398-9110.

WANTED: KIM-1 ROMs or complete board. The two 6530s must be in good working condition. Also interested in any information about dynamic memory controller chips. Glenn Valenta, 1626 Connecticut Ave., Joplin, MO 64801, (417) 782-3008.

FOR SALE: Sage II with 128K, two 640K disk drives, TeleVideo 925 green terminal, and more. Runs at 8 MHz. Perfect for programming. Like new. Asking $2300 or best offer. Gordy Kastner, 4760 North Creosote Place, Tucson, AZ 85749, (602) 749-1739.

FOR SALE: Four Intel 86/12A CPU multibus boards with 16-bit 8086, 32K dual port memory, 24 digital I/O lines, RS-232C port: $200 each or $725 for all. Two TRS-80 Model Is, Level II, 16K CPU and monitor; expansion interface, serial interface, and DD adapter; two SS/DD floppy drives; PROM programmer and *80 Micro*. $1000. Steve Wiisel, 5472 Delhi Park, Cincinnati, OH 34238, (513) 922-6450.

FOR SALE: Smoke Signal Broadcasting 6809 2-MHz SS-50 with 4-megabyte hard disk, DS/DD floppy, 96K, and more. Best offer. Also DS/DD drive, SS-50 chassis, SwTPC boards, two terminals, and Epson MX-80 printer. Robert Field, 1228 Carlotta Ave., Berkeley, CA 94707, (415) 527-7962.

FOR SALE: Four floppy drives, TEC-FB501, half-height, SS/DD direct drive, like new: $70 each or $65 each for two to four. Also, four Shugart 8-inch 800-2 drives: $75 each or $70 each for two to four. I pay shipping. Two Condor power supplies: $25 each. Steve Gilley, POB 810, Hermosa Beach, CA 90254.

FOR SALE: Hayes Smartmodem, 300 bps: $125. Rarely used. Overseas Crusades, 25 Corning Ave., Milpitas, CA 95035, (408) 263-1101 or David Nesmith, (408) 270-1185.

FOR SALE: Two IMSAI S-100 housings, two 8080 CPUs, 4K static RAM, and two MIOs. Dual North Star drives with interface. Ithaca Audio Z80 CPU, CCC 64K dynamic RAM. Four Godbout 8K RAMs. Two video interfaces. Extender/probe. Monitor. 8-inch drive. Best offer. R. Trinko, 185 Walnut St. #3, New Orleans, LA 70118, (504) 464-3368 or 866-0233.

WANTED: DDDC Disk Control Board; 32K, 48K, or 64K memory board and SMB2 I/O board for Technical Design Labs Xitan computer. William Leonard, 14956 Ronda Dr., San Jose, CA 95124, (408) 377-8582, evenings.

FOR SALE: IMSAI 8080 with ZPU processor board, 22-slot motherboard, 48K RAM, ROM monitor, one serial and three parallel I/O ports, cassette interface, Vistar GTX CRT, many extra boards, and more. Assembled and working. Asking $1100. Steve Dover, 821 Laramie, Wilmette, IL 60091, (312) 251-4683.

WANTED: Owners of true IBM-compatibles and users groups worldwide for exchange of opinions and self-written or public-domain software. Languages: BASIC, Pascal, assembler. Write in English, French, Spanish, or Italian. Mario Manuzzi, Via Serraglio, 37, I-47023 Cesena (FO), Italy.

WANTED: LNW-80 users to exchange software (user-written) and hardware modifications. Have written fast graphics printer dump that I'll supply source code for; also designed speech board and drive software I'll supply design for. Neil Breeden II, 2916 West 3875 S #4, West Valley City, UT 84119.

UNCLASSIFIED ADS MUST *be noncommercial, from readers who have computer equipment to buy, sell, or trade on a onetime basis. All requests for donated computer equipment must be from nonprofit organizations. Programs to be exchanged must be written by the individual or be in the public domain. Ads must be typed double-spaced, contain 50 words or less, and include full name and address. This is a free service; ads are printed as space permits.* BYTE *reserves the right to reject any unclassified ad that does not meet these criteria. When you submit your ad* (BYTE, *Unclassified Ads*, POB 372, *Hancock*, NH 03449), *allow at least four months for it to appear.*

B·O·M·B

BYTE's Ongoing Monitor Box

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BOMB *Results*

June's Seating Arrangements

Computing at Chaos Manor, composed by Jerry Pournelle "From the Living Room," wins June's top seating. Runner-up is Gregg Williams's "Debugging Techniques," followed by What's New in third. Steve Ciarcia's wrap-up on how to "Build the Home Run Control System, Part 3: The Software" is fourth. Arthur Huston wins $100 for placing fifth with "Structuring BASIC." In sixth: staff-written Microbytes. Ask BYTE, conducted by Steve Ciarcia, is next, and "Choosing a Programming Language" not only wins eighth but its author, Gary Elfring, wins $50.

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SEND FOR YOUR SUBSCRIBER I.D. CARD

1) If you are a new subscriber or have lost your I.D. card, circle #1 on the Reader Service Card; **attach mailer label**. We will immediately send your personal TIPS subscriber card.

GET PREPARED

2) Write your Subscriber Number, as printed on your Subscriber I.D. Card, in boxes in Step 5 below. (Do not add 0's to fill in blank boxes)

3) Write numbers for information desired in boxes in Step 7b below. (Do not add 0's to fill in blank boxes.)

CALL TIPS

4) Now, on a Touch-Tone telephone dial: **(413) 442-2668** and wait for voice commands.

ENTER YOUR SUBSCRIBER AND ISSUE NUMBERS

5) When TIPS says: "Enter Subscriber Number"
(Enter by pushing the numbers and symbols [# or * enclosed in the boxes] on telephone pad ignoring blank boxes)
Enter □ □ □ □ □ □ □ □ □ □ # #

6) When TIPS says "Enter magazine code & issue code"
Enter 1 # 9 5 # #

ENTER YOUR INQUIRIES

7a) When TIPS says "Enter (next) Inquiry Number"
Enter one inquiry selection from below (ignore blank boxes)

b) Repeat 7a as needed (maximum 17 inquiry numbers)

1. □ □ □ # #   6. □ □ □ # #   10. □ □ □ # #   14. □ □ □ # #
2. □ □ □ # #   7. □ □ □ # #   11. □ □ □ # #   15. □ □ □ # #
3. □ □ □ # #   8. □ □ □ # #   12. □ □ □ # #   16. □ □ □ # #
4. □ □ □ # #   9. □ □ □ # #   13. □ □ □ # #   17. □ □ □ # #
5. □ □ □ # #

END SESSION

8) End session by entering * * 9 1 # #

9) Hang up after hearing final message
If you are a subscriber and need assistance, call (603) 924-9281.

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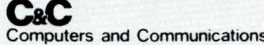
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Computers and Communications

Inquiry 271


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